AVAILABILITY AND USE OF SCHOOL LABORATORY FACILITIES AND THEIR INFLUENCE ON STUDENTS' ACHIEVEMENT IN SCIENCES: A CASE OF SECONDARY SCHOOLS IN TRANS-NZOIA DISTRICT.

BY

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DECLARATION

I declare that this thesis is my original work and has not been presented to any university for the award of any degree. No part of this thesis can be copied without prior permission of the author and/ or Moi University.

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ABSTRACT

Laboratory activities offer important experiences in the learning sciences that are unavailable in other school disciplines. For many years, laboratory experiences have been shown to promote key science education goals (Hudson, 1993). This implies that laboratory experiences are therefore very important to a student as they enhance better understanding of science and lead to better performance in sciences. Lack of adequate exposure to practical work has been noted as one of the contributing factors to dismal performance in examinations. G.O.K (1995) observes that some students saw and handled experimental equipments only during national examinations. The purpose of this study was therefore to investigate availability and use of school laboratory facilities and their influence on students' achievement in sciences in secondary schools in Trans- Nzoia district

A descriptive survey research design was employed targeting a population of two hundred and seventy one teachers, fifty four head teachers and fifty four laboratory assistants in fifty four Public Secondary schools in Trans-Nzoia district. A sample of one hundred and eight science teachers, twenty two head teachers and twenty two laboratory assistants was selected through stratified random sampling method. Questionnaires were used in data collection. Interview schedules and checklist for laboratory assistants were also used in the study. Frequency distribution tables, percentages and means were used to summarize the data, while chi-square was used to test the relationship between the independent and dependent variables.

The study findings supported the premise that quality and adequate use of laboratory facilities in schools impact on students' achievement in science subjects. It further noted that good laboratory facilities (95.5%) contribute to good performance in sciences. Lack of apparatus (88%), chemicals (86.1%), and laboratory furniture (79.6%) among others were some of the factors that hinder students from handling/ manipulating the apparatus on their own. This implies that the students are deprived of the necessary skills that can make them be able to carry out an experiment on their own hence hindering them from performing well in sciences.

DEDICATION

To my beloved wife, Nancy, and children: Wangare, Gitahi and Wangeci.

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LIST OF ABBREVIATIONS

AASA - American Association of School Administration.

AIDS - Acquired Immune Deficiency Syndrome.

DEO - District Education Officer.

EPA - Environmental Protection Agency.

GOK - Government of Kenya

INSET - In Service Training

KCPE - Kenya Certificate of Primary Education

KCSE - Kenya Certificate of Secondary Education.

KNEC - Kenya National Examinations Council

SMASSE - Strengthening of Mathematics and Sciences in Secondary Schools.

UNESCO - United Nations Education, Scientific and Cultural Organization.

USA - United States of America

SCRT - Serial Choice Research Time.

SLEI - Science Laboratory Environment Inventory

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter outlines the background to the problem of study, statement of the problem, purpose and objectives of the study. It also includes the hypotheses, significance of the study, assumptions of the study, scope and limitations of the study and the theoretical framework. The chapter finally concludes with the definition of terms used in the study.

1.1 Background of the problem

The importance of a school laboratory can be explained by its usage in various contexts. People working in industrial laboratories of various industries require some laboratory knowledge in their day to day work. Students too require laboratory skills in order to be able to make observations; plan investigations; review what is already known in light of experimental evidence; use tools to gather, analyze, and interpret data; propose explanations and predictions; and communicate the results. While most people in our society recognize and appreciate the essential role of laboratories in schools, science subjects' remain the most poorly performed in our secondary schools in the KCSE national examinations (KNEC, 1995).

Poor performance in sciences has been attributed to several factors. Thuo (1985) observed factors such as over-enrolment, poor syllabus coverage, poor teaching methods and poor attitudes towards the subject as some of them. This has contributed to various changes in the science subjects' curriculum in Kenya since independence but students still perform poorly. Similarly KNEC (1995) report indicates that students perform poorly

in spite of science subject examinations testing similar skills. This implies that the problem that leads to students' poor performance in the subjects has not been adequately addressed.

Many countries in Africa and other developing countries in the world embrace universal primary education even though it is not clear, even to the policy makers, how the increasing demand for the limited number of secondary school places and facilities could be increased to enhance access to and participation in the formal secondary school education. Secondary school education has not attracted the same active resource mobilization for its development as basic and higher education, despite the greater expectations from the society. The resources for this sub-sector have often been lacking in both quality and quantity (UNESCO, 2003). Thus, limited resources to schools limit the funds available for laboratory facilities.

The laboratory, if used properly, is especially important in the current era in which inquiry has re-emerged as a central style advocated for science teaching and learning. Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (Hurd, 1969). Therefore, for laboratory work to facilitate the acquisition and development of these skills the principal focus of laboratory activities

should not be limited to learning specific scientific methods or particular laboratory techniques; instead, students in the laboratory should use the methods and procedures of science to investigate phenomena, solve problems, and pursue inquiry and interests.

According to the International Commission on Education for the twenty-first century in Sub-Saharan Africa, school facilities maintenance and furniture have deteriorated so drastically that they cannot meet the challenges of the 21st century. A report of the task force on student discipline and unrest in secondary schools notes that, the high demand for secondary schools places in the face of limited opportunities at this level, has not only contributed to congestion in the few education facilities available, but has also lowered the standards of education especially in public schools (G.O.K, 2001). Commenting on the environment within schools and their environs the report observed that they were hazardous, making the schools unattractive to the learners hence making it difficult to retain them and offer quality learning.

Taylor (2002) observes that although school laboratories are everywhere and are acknowledged are as conventional locations for teaching and learning process, little concern and appreciation is given to this important resource. Improvements in this resource have often been termed as a luxury that schools cannot afford. Many school administrators and managers hardly appreciate the role of school laboratories and their environment towards achievement. They would often attribute such achievement to good discipline, hard work and cooperation between teachers, students and parents. Learning is an art, the mere provisions of enough teachers and reading textbooks does not guarantee achievement of high educational level, attitude and good behaviour for tasks ahead. This

therefore shows that unless the role of the laboratory is appreciated by all the stakeholders in school there will always be poor allocation of funds to laboratories and hence poor performance among students.

More informal atmosphere and opportunities for more interaction among students and their teachers and peers can promote positive social interactions and a healthy learning environment conducive to meaningful inquiry and collaborative learning. The laboratory offers unique opportunities for students and their teachers to engage in collaborative inquiry and to function as a classroom community of scientists. Such experiences offer students opportunities to consider how to solve problems and develop their understanding. Hodson (2001) further observed that quite often teachers rarely do in laboratories what they say they intend to do. Thus, there can also be a mismatch between a teacher's rhetoric and classroom behavior that can send mixed messages to students.

A task force on student discipline and unrest in secondary schools (G.O.K, 2001) noted that among the causes of indiscipline and unrest in schools, was a big disparity in the provision and maintenance of physical facilities, laboratories included, between schools especially when such schools are neighbours. The report observed that this was enough cause of stress and frustration among students who are to be tested with the same standards. When a school is allowed to deteriorate physically, the human spirit within the school also declines (Sadker and Sadker, 1994).

Research has shown growing evidence that conditions like these and many other aspects of school buildings have many and often negative impact on students achievement.

Studies carried out in low and middle income countries (Hungary, Indonesia, Trinidad and Tobago and Venezuela), indicate that the school and classroom characteristics accounted up to 40 percent of the differences in learning achievement. According to Harbison and Hanushek (1992) out of the 34 studies carried out in these countries, 22 positively supported the contribution facilities and laboratories make towards learners achievement. Often the goals articulated for learning in the laboratory have been almost synonymous with those articulated for learning science more generally.

Hodson (2001) claimed that in the past 30 years the motives for laboratory/practical work have remained unchanged although relative priorities may have shifted somewhat. To guide teaching and learning, it is very important for both teachers and students to be explicit about the general and specific purposes of what they are doing in the classroom. Explicating goals for specific students' learning outcomes should serve as a principal basis upon which teachers design, select, and use activities. The goals can also serve as the most important basis for assessment of students and of the curriculum and teaching strategies. It is important to acquire information and insight about what is really happening when students engage in laboratory activities, that is, we need to examine what the students perceive in the light of important goals for science learning.

In a project titled "Strengthening of Mathematics and Science in Secondary School Education" (SMASSE), the Kenyan and Japanese governments conducted some baseline studies in nine pilot districts. One single facility that struck the team due to its state was the science laboratories. Some of the schools visited did not have a building they could call a laboratory. For certain students' experimental equipment were only seen and used

during national examinations when students are taken to neighbouring schools for practical examinations (KNEC, 1995). The result has been under achievement and disillusionment among the students.

According to KNEC (2006), questions testing experimental design are poorly done, an indication that practical approach to teaching is not practiced in our schools. It further says that it is common for students to have not handled an apparatus in four years only to be expected to use it either during the mocks or the final examination (KCSE). This should be discouraged because it is not only unfair to the candidate but also denies the candidate the chance to learn certain life skills. From the foregoing, it is clear that practical work much of which is carried in laboratories is important because it enhances better understanding of scientific concepts besides facilitation of the development of skills and attitudes. The laboratory is, however, only able to meet these goals if it is well equipped and regularly used in the course of teaching. If these conditions are not met, then the teaching and learning in science is greatly hindered. It is because of this that this study sought to investigate the availability and use of laboratories in selected secondary schools in Trans-Nzioa.

1.2 Statement of the problem

KNEC (1995) reports that science subjects remain the most poorly performed subjects in our secondary schools' KCSE examinations. It further indicates that students perform poorly in sciences inspite of science subject examinations testing similar skills. KNEC (2001) stipulates that for a student to get an overall B (minus) grade and above in chemistry, biology and physics they have to obtain forty percent in the practical paper.

This underlines the importance of practical lessons in schools. Poor performance in science subjects has been attributed to several factors such as; inappropriate syllabus coverage, overloaded curriculum, shortage of qualified teachers, poor teaching methods (KNEC, 1995), over-enrolment and negative attitudes towards the subjects (Thuo, 1985). These factors have contributed to various changes in the science curriculum in Kenya since independence. However, poor performance in the science subjects persists. This implies that the problems that lead to students' poor performance in the science subjects have not been adequately addressed. Several KNEC reports have raised issues with the state of laboratory facilities and how these facilities are used by students. It is in view of this that the study is designed to undertake an investigation on school laboratory facilities and their influence on students' achievement in science subjects in secondary schools in Trans-Nzoia district, and suggest measures that could possibly be taken to improve the performance in these subjects.

1.3 Purpose of the Study

The purpose of this study was to investigate the availability, state and use of the school laboratory facilities and their influence on students' achievement in science subjects in secondary schools in Trans-Nzoia district.

1.4 Objectives of the study

The main objective of the study was to find out the influence of laboratory facilities on students' achievement in science subjects. From the main objective, three specific objectives were derived;

a) To establish the availability of laboratory facilities in secondary schools in Trans-Nzoia district.
b) To establish the state of school laboratory facilities and its influence on students' achievement in science subjects in secondary schools in Trans-Nzoia district.
c) To investigate the relationship between laboratory use and its influence on students' achievement in science subjects in secondary schools in Trans-Nzoia district.

1.5 Research hypotheses

The study tested the following null hypotheses;-

Ho_1: There is no relationship between the state of school laboratory facilities and students achievement in science subjects in national examinations.

Ho_2: There is no relationship between the frequency of laboratory sessions and students' achievement in science subjects in national examinations.

Ho_3: There is no relationship between the provision of laboratory facilities and students' achievement in science subjects in national examinations.

1.6 Justification of the study

For a student to get a B- and above grade in science subjects he/ she has to pass the practical paper. The places a lot of importance on practical work in deciding the grade a student gets in any science subject in KCSE examination.

According to Vision 2030 (G.O.K, 2007), public and private universities are encouraged to expand enrolment, with an emphasis on science and technology courses. Kenya intends

to have international ranking for her children's achievement in mathematics, science and technology.

Practical skills also find a wide application in the world of work including the Jua- Kali sector which absorbs a large number of school graduates. The laboratory is one place where training in practical skills is laid.

The KNEC report (2003) also advises that the theoretical teaching should be avoided as much as possible and puts it that teachers should give the class a project or experiment to do during and at the end of each topic to sharpen their problem solving skills. This has necessitated the researcher to undertake a study on the school laboratory facilities and their influence on students' achievement in science subjects in secondary schools in Trans-Nzoia district.

1.7 Significance of the study

The study is expected to contribute to the development of knowledge about the role of school laboratory in teaching – learning process in science subjects. The study sensitizes the stakeholders in education to re-evaluate their position as regards provision of school laboratory facilities in order to increase interest and participation in science subjects among secondary school students. The study also assists the education policy makers to come up with strategy intervention especially in school laboratory facilities provision. The curriculum developers, science teachers and the school management will find the findings beneficial as regards laboratory facilities provision and management.

1.8 Scope and limitations of the study

The following was the scope and limitations of the study;

1.8.1 Scope

The study confined itself to the availability, state and use of laboratory facilities and did interview the science teachers, head teachers and the laboratory assistants in public secondary schools who are the direct implementers of the teaching programme in science subjects. The study also limited itself to student academic performance in science subjects in the years 2002 to 2006.

1.8.2 Limitations

The following were the limitations of the study:

1. Since the sample respondents were drawn from some selected secondary schools in Trans-Nzoia, the effects found are mainly reflective of the situation in the district. Hence, the findings may not be representative of all secondary schools in Kenya.
2. The study limited itself to the sample size; the selected secondary schools in Trans-Nzoia district; the effects of school laboratory facilities on students' achievement in science subjects found only reflects the situation in the district.
3. The study also limited itself to the variable laboratory facilities since there were many other factors that could influence performance.
4. Getting information unknown to the respondents could at times prove difficult.

1.9 Assumptions of the study

The following assumptions were made in this study:-

- All respondents would be cooperative, and would honestly and accurately respond to all the items in the research instruments.
- All school managers were aware of the education (education standards) regulations that govern the science laboratories standards in schools.
- Well equipped laboratories would register better achievement among students.

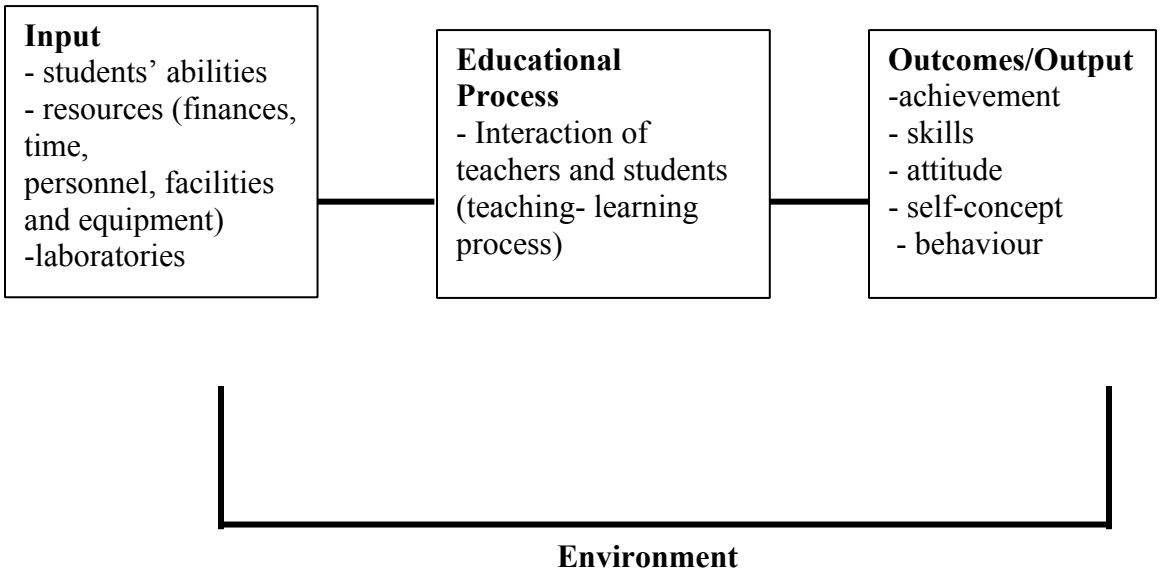
1.10 Theoretical framework

The study was guided by Bailey's (1987) education systems approach. The system attempts to describe students' behaviour in relation to inputs in an education system. This system consists of three stages which are: input, educational process and output/ outcomes.

The first are the inputs that the school gathers and coordinates from the environments. These inputs include; human resources, facilities such as laboratory facilities, buildings, equipments, playing fields and grounds, materials and time. Secondly, these inputs, laboratory facilities included, are processed or transformed and interact, through teaching learning process for example, experiences got through experiments, to give the product or the output which are students achievement in national examinations (KCSE), skills development and attitude, which forms part of the student self concept.

Thirdly, these products /output provide feed back to the environment which consists of parents, governments, employers and donors. The environmental reaction provides a feed back calling out the schools to fashion out the systems. This can be done through providing more facilities such as laboratory facilities in order to enhance students' achievement.

According to figure 1.10.1, laboratory facilities are part of the inputs whose quality influences educational process that is, teaching and learning of science and consequently translate into higher achievement, improved practical skills and positive attitude towards sciences among students.



Source: Bailey (1987)

Figure 1.10.1.The diagram above shows the relationship between inputs and the outputs of an education system.

1.11 Definition of terms

Attitude: - It is the positive feeling or mental state of readiness towards the use of laboratory facilities.

Co-Curricular activities: - Are activities at a school pursued in addition to the normal academic discipline. In this study, these activities will include sports (athletics, football, handball, hockey, netball, rugby, volleyball, and basketball), drama, music, science congress and indoor games (chess, scrabble, and table tennis).

Cognitive skills: - It refers to the mental skills/ skills of the mind.

Inquiry: - Refers to detailed investigation by students using the cognitive and manipulative skills within a laboratory setting.

Investigation: - It is examining the facts about something in order to discover the truth.

Laboratory: - A room where students use special equipment to carry out well-defined procedures in science.

Laboratory facilities: - It refers to the laboratory buildings, apparatus and chemicals inside, reference text books and practical manuals.

Learning environment: - This represents the physical, social and cultural context in which learning occurs. In this study, learning environment will be limited to the philosophical aspect of the environment.

Manipulative skills: - Refers to the skills acquired by a student to be able to control or use something within the laboratory in a skilful way or as required.

Physical facilities: - Refers to the items of capital expenditure in a school that can be used continuously over a long period of time. In this study these facilities will include classrooms, laboratories, workshops/home science rooms, play fields, bathroom and toilets, fence, kitchen, dining rooms, staff houses and general school compound.

Public schools: - These are schools run and maintained at the public expense, such schools are provided for by the government that pays for teachers' supervision and some limited direct funding and parents who pay for students' tuition, development of facilities and upkeep and other well wishers, sponsors and individuals.

Poor performance: - It is the inability for students to get the required grade (D+) which is considered as a pass mark for any subject by KNEC

Resource: - Is any physical or virtual entity of limited availability for example, laboratory facilities that are made available for the students to enhance their manipulative skills.

Science Subjects: - These are the three subjects namely; chemistry, physics and biology.

Students' achievement: - It is the ability to successfully finish or gain in or of something. Student achievement during schooling will refer to examination scores at KCSE.

Wastage: - Refers to the dual problem of repeating and dropping out.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews and applies current literature on several attributes of the school buildings and related facilities at both local and global levels that have been found to affect science learning. What is discussed in this chapter includes adequacy of laboratory facilities, their state and use and how they affect students' achievement in the science subjects. It is from such background that educational stakeholders can seize the opportunity to improve this vital resource component of the educational systems to facilitate the transmission of value, stimulate and aid creativity, mental perception and cause joy to the learners.

2.2 Laboratory in Science Education

Science educators such as Schwab (1962), Hurd (1969) and Lunetta and Tamir (1979) have expressed the view that uniqueness of the laboratory lies principally in providing students with opportunities to engage in processes of investigation and inquiry. In addition Tobin (1990) prepared a synthesis of research on the effectiveness of teaching and learning in the science laboratory. He proposed a research agenda for science teachers and researchers. Tobin suggested that meaningful learning is possible in the laboratory if the students are given opportunities to manipulate equipment and materials in an environment suitable for them to construct their knowledge of phenomena and related scientific concepts. He also claimed that, in general, research had failed to provide evidence that such opportunities were offered in school science. Roth (1994) suggested that although laboratories have long been recognized for their potential to facilitate the learning of science concepts and skills, this potential has yet to be realized.

Currently, we are in a new era of reform in science education. Both the content and pedagogy of science learning and teaching are being scrutinized, and new standards intended to shape meaningful science education are emerging. Bybee (2000) and Lunetta (1998) emphasize the importance of rethinking the role and practice of laboratory work in science teaching. This is especially appropriate because in recent decades we have learned much about human cognition and learning (Bransford, et al, 2000). In addition, according to Krajcik and others (2001), learning by inquiry is posing challenges for teachers and learners. Inquiry refers to diverse ways in which scientists study the natural world, propose ideas, and explain and justify assertions based upon evidence derived

from scientific work. It also refers to more authentic ways in which learners can investigate the natural world, propose ideas, and explain and justify assertions based upon evidence and, in the process, sense the spirit of science.

The National Science Education Standards in the United States and other contemporary science education literature continue to suggest that school science laboratories have the potential to be an important medium for introducing students to central conceptual and procedural knowledge and skills in science (Bybee, 2000). Hodson (1993) emphasized that the principal focus of laboratory activities should not be limited to learning specific scientific methods or particular laboratory techniques; instead, students in the laboratory should use the methods and procedures of science to investigate phenomena, solve problems, and pursue inquiry and interests. Baird (1990), observed that the laboratory learning environment warrants a radical shift from teacher-directed learning to "purposeful-inquiry" that is more student-directed.

2.3 Learning Science in the School Laboratory

Tobin (1990) observes that laboratory activities appeal as a way of allowing students to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science. This important assertion may be valid, but current research also suggests that helping students achieve desired learning outcomes is a very complex process. According to Gunstone (1991), using the laboratory to have students restructure their knowledge may seem reasonable but this idea is also naive since developing scientific ideas from practical experiences is a very complex process. Gunstone and Champagne (1990) suggested that meaningful learning in the laboratory would occur if

students were given sufficient time and opportunities for interaction and reflection. Gunstone (1991) wrote that students generally did not have time or opportunity to interact and reflect on central ideas in the laboratory since they are usually involved in technical activities with few opportunities to express their interpretation and beliefs about the meaning of their inquiry.

Research has also suggested that while laboratory investigations offer important opportunities to connect science concepts and theories discussed in the classroom and in textbooks with observations of phenomena and systems, laboratory inquiry alone is not sufficient to enable students to construct the complex conceptual understandings of the contemporary scientific community. If students' understandings are to be changed toward those of accepted science, then intervention and negotiation with an authority, usually a teacher is essential (Driver, 1995). Thus for this to occur in a student, teachers should then attempt to vary the learning environment in which students develop their understanding of scientific concepts, science inquiry skills, and perceptions of science.

2.4 Laboratory Work and Students' Attitudes

Several studies on laboratory work and students' attitudes published in the 1970s and early 1980s, reported that students enjoy laboratory work in some courses and that laboratory experiences have resulted in positive and improved student attitudes and interest in science. Science education literature continues to articulate that laboratory work is an important medium for enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science. The failure to examine effects of various school science experiences on students' attitudes is unfortunate since experiences that promote

positive attitudes could have very beneficial effects on interest and learning. The failure to gather such data is especially unfortunate at a time when many are expressing increasing concerns about the need for empowerment of women and underrepresented minority people in pure and applied science fields (Hofstein and Lunetta 1982).

2.5 Conditions for Effective Learning in Laboratories

Since creating a healthy learning environment is an important goal for many contemporary science educators, there is need for further research that will assess how time spent in laboratory activities and how the nature of students' activities in the laboratory affect the learning environment. The science laboratory is central in our attempt to vary the learning environment in which students develop their understanding of scientific concepts, science inquiry skills, and perceptions of science. The science laboratory is a setting in which students can work cooperatively in small groups to investigate scientific phenomena.

Hofstein and Lunetta (1982) and Lazarowitz and Tamir (1994) suggested that laboratory activities have the potential to enhance constructive social relationships as well as positive attitudes and cognitive growth. The social environment in a school laboratory is usually less formal than in a conventional classroom; thus, the laboratory offers opportunities for productive, cooperative interactions among students and with the teacher and has the potential to promote an especially positive learning environment. The learning environment depends markedly on the nature of the activities conducted in the laboratory, the expectations of the teacher (and the students), and the nature of assessment. It is influenced, in part, by the materials, apparatus, resources, and physical

setting, but the learning environment that results is much more a function of the climate and expectations for learning, the collaboration and social interactions between students and teacher, and the nature of the inquiry that is pursued in the laboratory.

2.6 Students' Perceptions of the Laboratory Learning Environment

The need to assess the students' perceptions in the science laboratory was approached seriously by a group of science educators in Australia (Fraser and others, 1993), who developed and validated the Science Laboratory Environment Inventory (SLEI). This instrument, consisting of eight learning environment scales, was found to be sensitive to different approaches to laboratory work, that is, high inquiry or low inquiry and different science disciplines such as biology or chemistry, etc (Hofstein and others, 1996). The SLEI has been used in several studies conducted in different parts of the world.

One comparative study examined students' perceptions in six countries: United Kingdom, Nigeria, Australia, Israel, United States, and Canada (Fraser and McRobbie, 1995). Fraser and others (1993) in Australia found that students' perceptions of the laboratory learning environment accounted for significant amounts of the variance of the learning beyond that due to differences in their abilities. In Israel, in the context of chemistry and biology learning, Hofstein and others (1996) used a Hebrew version of the SLEI. They compared students' perceptions of the actual and preferred learning environment of laboratories in chemistry and biology classes. They found significant differences between chemistry and biology laboratory environments in two scales, namely, integration, which describes the extent to which the laboratory activities are integrated with non laboratory activities in the classroom and open-endedness, which

measures the extent to which the activity emphasizes an open-ended approach to investigation. Differences were also found in comparing the students' perceptions of the actual and preferred learning environments.

A more recent study conducted in Israel by Hofstein and others (2001) in the context of learning high school chemistry showed clearly that students who were involved in inquiry-type investigation found the laboratory learning environment to be more open-ended and more integrated with a conceptual framework than did students in a control group. If positive students' perceptions of the science laboratory learning environment, that is, cooperative learning, collaboration, and developing a community of inquiry are among the important intended outcomes of school laboratory experiences, then these outcomes should be assessed by teachers as a regular part of course evaluation.

2.7. Social Interaction in Laboratories and its Consequences for Learning

Science educators increasingly perceive the school science laboratory as a unique learning environment in which students can work cooperatively in small groups to investigate scientific phenomena and relationships. Hofstein and Lunetta (1982), Lazarowitz and Tamir (1994), and Lunetta (1998) suggested that laboratory activities have the potential to enable collaborative social relationships as well as positive attitudes toward science and cognitive growth. More informal atmosphere and opportunities for more interaction among students and their teacher and peers can promote positive social interactions and a healthy learning environment conducive to meaningful inquiry and collaborative learning. The laboratory offers unique opportunities for students and their teacher to engage in collaborative inquiry and to function as a classroom community of scientists. Such experiences offer students opportunities to consider how to solve

problems and develop their understanding. Through collaboration, they can also come to understand the nature of an expert scientific community. These are among the learning outcomes now thought to be very important in introductory science. Through these laboratory activities, students' potential in science subjects is realized and enhanced by the teachers, which results in better learning hence better achievement in the subjects at national examinations.

Large numbers of studies demonstrated distinct benefits in students' achievements and productivity when cooperative learning strategies were utilized in the classroom-laboratory. Okebukola and Ogunniyi (1984) compared groups of students who worked cooperatively, competitively, and as individuals in science laboratories and found that the cooperative group out performed the other groups in cognitive achievement and in process skills. Similarly, Lazarowitz and Karsenty (1990) found that students who learned biology in small cooperative groups scored higher in achievement and on several inquiry skills than did students who learned in a large group class setting. Tobin (1990) observes that the more informal atmosphere and opportunities for more interaction among students and their teacher and peers can promote positive social interactions and a healthy learning environment conducive to meaningful inquiry and collaborative learning.

This emphasizes the need of a well equipped laboratory in a school and the frequent use of the same laboratory by the students. Laboratory use enhances social relationships as well as positive attitudes toward science subjects and cognitive growth and hence the need for this study.

2.8 Differences in Learning Styles and Cognitive Abilities

According to Tobin and Gallagher (1987) it is difficult tailoring laboratory activities to the needs of diverse students. This has caused some teachers to avoid laboratory investigations, particularly when working with students having low motivation and skill. Dreyfus (1986) made an attempt to redesign science laboratory activities to be used with mixed ability classes. He suggested that teachers could design investigations to be used effectively by students with different levels of relevant knowledge and with different cognitive abilities. He suggested that teachers who are well informed about their students' abilities should be able to select appropriate approaches and levels of sophistication to align these with their students' needs and abilities. Tailoring school experiences for students with different backgrounds, knowledge, and levels of cognitive ability is especially important in an era in which achieving scientific literacy for all students has become a major goal.

Adar (1969) postulated that a relationship exists between a student's motivational pattern and characteristics (reasons for learning) and his or her preference for certain instructional techniques in the science classroom or laboratory. Kempa and Diaz (1990) probed this relationship. Their study revealed a number of strong relationships between motivational traits and instructional preferences. They found that students they characterized as conscientious preferred more formal learning environments while others, more motivated by curiosity, enjoyed learning more open-ended situations such as in inquiry laboratory activities. Doing practical work was appealing to the conscientious students, but only when those experiences involved explicit instructions, guidance, and

closure. On the other hand, students they characterized as sociable displayed a distinct preference for group discussions. Other students whom they characterized as achievers preferred more individualized or whole class instructional situations. These findings suggested the importance of rethinking and reshaping the work of students in the science laboratory to engage students in ways consistent with their diverse experiences, knowledge, and cognitive preferences, perhaps through small group collaboration and inquiry or occasionally through independent inquiry.

2.9 Students' Perceptions of Teachers' Goals in Science Laboratory Activities

According to Chang and Lederman (1994), students often do not have clear ideas about the general or specific purposes for their work in science laboratory activities. Other studies have shown that students often perceive that the principal purpose for a laboratory investigation is either following the instructions or getting the right answer. They may perceive that manipulating equipment and measuring are goals but fail to perceive much more important conceptual or even procedural goals. Students often fail to understand and to question the relationship between the purpose of their investigation and the design of the experiment they have conducted. They do not connect the experiment with what they have done earlier, and they seldom note the discrepancies between their own concepts, the concepts of their peers, and those of the science community.

To many students, "a laboratory" means manipulating equipment but not manipulating ideas. Mismatches often occur between teachers' perceived goals for practical work and students' perceptions of such activities (Hodson, 1993). Since there is evidence that the goals of instruction are more likely to be achieved when students understand those goals,

he concluded that teachers should be much more concerned with helping students understand the general goals of the laboratory work. Since specific objectives are often different from one laboratory investigation to another, students should be helped to understand the purposes for each investigation in a pre-laboratory session and to review those purposes in post-laboratory reporting and discussion. Hodson (2001) further observed that often teachers do not do in laboratories what they say they intend to do. Thus, there can also be a mismatch between a teacher's rhetoric and classroom behaviour that can send mixed messages to students and other observers.

Pre-laboratory, laboratory and post-laboratory sessions enhances the students understanding of the objectives of the subject hence improving on the attitude of the students towards the subject. They will also enable students to have clear ideas about the general or specific purposes for their work in science laboratory activities, which will lead to better performance in the science subjects.

2.10 School Laboratories as Conventional Locations for Teaching and Learning Process

Griffins (1996) observed that a head that puts all his attention into trying to improve the teaching- learning of an academic subject is likely to be disappointed by the ultimate examination result. Available evidence indicates that infants and children learn more rapidly in a stimulating and varied physical environment, which meets human basic needs. Taylor (2002) notes that there cannot be a separation between the learning process and the physical environment; they are integral parts of each other.

2.11 Repair, Maintenance and State of Laboratory Facilities

Repair and maintenance of existing buildings and related facilities is not only a legal requirement but, as observed by Thomas and Simkins (1987), a legal obligation. This area requires continued funding to ensure that fine facilities are maintained in a state of acceptable standards. Schools have control over a significant part of their expenditure and can determine their own educational priorities- repair and maintenance of their buildings and related facilities. However, it is saddening to discover that long term planning for such repairs and maintenances has largely been ignored and in some institutions development plan for the years ahead are not put in place. This is reflected in state of their facilities and the usual complaint of limited funds.

According to Holloway (2000), a government accounting office report on school facilities; America's schools report differing condition. He observes that about a third of the school buildings in the United States need extensive repair or replacement of at least one major building feature, such as roofs, windows and doors, ventilations and air conditioning. He further observes that many of these conditions pointed out constitute clear safety code violation. And according to the report, schools requiring these renovations are among the list prepared to meet the technology of the twenty first century. The same report notes that more than half of the US schools have unsatisfactorily environmental conditions. Counted among these deficiencies are lack of appropriate acoustics for noise control, poor ventilation, and adequate physical security.

The significant amount of time those students and their teachers spend inside school laboratories and how often they use related facilities during the course of their academic periods underlines the importance of an orderly practical teaching and learning. Although schools receive monies for repair and maintenance, many public schools in Kenya are neglected. So serious is the problem that some head teachers fear that unless the government intervenes, the safety of the students in the available laboratories could be compromised.

Science is fundamentally an experimental subject; education in chemistry must have an experimental value. In other words, every learner must have a practical scientific experience. However, the reality involves learning sciences through pictures in books, drawings in the blackboard and questions in examinations. The gap between ideal learning and the real situation is basically due to shortages in budget, laboratories, equipment, chemicals, and the problems relative to repairs and maintenance.

Poor quality of education negatively affects enrolment, participation, completion rate and quality of graduates from the education system, and subsequently, the country‘s development (World Bank, 1995). Low grades in mathematics and sciences are interpreted to mean that the students have not learnt well or the subjects are either difficult to teach or learn, regardless of other factors affecting teaching and learning including school and home environment (Heneveld and Craig, 1996). Other factors include shortage of teachers, inadequate and poor facilities; shortage of instructional materials and low teachers' morale due to low remuneration and poor terms of service.

Studies on how to improve education quality indicate that this could be done through improvement of quality of teachers - making them more effective in the way they teach (World Bank, 1995).

In Kenya, the decline in education quality, participation and retention rates have been attributed to high cost of education and rising levels of poverty as many households are not able to effectively pay school levies (G.O. K, 2003)**.** Previous attempts to improve quality at secondary level included the introduction of Kenya Junior Secondary Education (KJSE) examinations to ensure that those who joined community (Harambee) schools received quality education before proceeding to Form III or joining the world of work (G.O. K, 1988). Moreover, in response to rapid expansion of both primary and secondary and acute shortage of qualified teachers, especially in the late 1960s and early 1970s, the Ministry of Education has had in-service training of teachers as a top priority so as to enhance the quality of teaching and learning (G.O. K, 1982). This has been done through different types of in-service courses mounted during the school holidays to supplement the number of teachers graduating from teacher training colleges. The focus of these courses was on untrained teachers, under-qualified teachers or orienting teachers to new curricula. However, none of these was institutionalized nor aimed at general professional and capacity development in the teaching profession.

2.12 Teachers' Expectations and Behaviour in Using the Laboratory

Tobin and Gallaggher (1987) found that science teachers rarely, if ever, exhibit behaviour that encourages students to think about the nature of scientific inquiry and the meaning and purposes for their particular investigation during laboratory activities. On the basis of

a comprehensive study on implementation of the laboratory in schools in British Columbia, Gardiner and Farrangher (1997) found that although many biology teachers articulated philosophies that appeared to support an investigative, hands-on, minds-on approach with authentic learning experiences, the classroom practice of those teachers did not generally appear to be consistent with their stated philosophies. As noted in the preceding section, Hodson's (2001) observations of the mismatch between teacher's rhetoric and practice, also complicates obtaining valid and reliable information based only upon teachers' self-reports.

Several studies have reported that very often teachers involved students principally in relatively low-level, routine activities in laboratories and that teacher–student interactions focused principally on low-level procedural questions and answers. Marx et al. (1998) observe that science teachers often have difficulties helping students ask thoughtful questions, design investigations, and draw conclusions from data. DeCarlo and Rubba (1994) reported similar findings in chemistry laboratory settings. Teachers are often confused about their role in instruction when students are engaged in hands-on activity. Many teachers are concerned about an adjustment they may have to make in their teaching style to facilitate hands-on programs as well as how students will react to increased responsibility and freedom.

Often teachers do not perceive that laboratory activities can serve as a principal means of enabling students to construct meaningful knowledge of science. They also do not engage students in laboratory activities in ways that are likely to promote the development of science concepts. They may not perceive that they can manage laboratory activities in

ways that are consistent with contemporary professional standards. In addition, many teachers do not perceive that helping students understand how scientific knowledge is developed and used in a scientific community is essentially an important goal of laboratory activities for their students.

Many science teachers do not utilize or manage the unique environment of the school laboratory effectively. Conditions are especially demanding in science laboratories in which the teacher is to act as a facilitator who guides inquiry that enables students to construct more scientific concepts. Contemporary teaching standards place a heavy burden on the science teacher. Inquiry-focused teaching now rests on the constructivist notion that learning is a process in which the student actively constructs her or his own ideas that are linked with other ideas in increasingly complex networks. The constructivist model, when practiced, is a relatively radical departure from traditional teaching and learning practice (Cohen, 1990).

In addition, many teachers lack experience with assessment methods aimed at assessing their students' understanding and performance in the science laboratory (Yung, 2001). As a result, in many cases, students' final grades do not include a component that directly reflects their performance in laboratory work and their understanding of that work. Furthermore, Brickhouse and Bodner (1992) reported that students' concern about their grades has a strong influence on teachers' practices. More specifically, they suggested that some teachers will emphasize goals for learning and use teaching techniques that are aligned with students' ability to earn high grades. The need for meaningful, long-term professional development for science teachers on these issues and for better

communication between the science education research community and the community of science teachers is abundantly clear.

2.13 The Laboratory Guide

In most school laboratory activities, the student's laboratory guide, handbook, or worksheet continues to play a central role in shaping the students' behaviours and learning. The guide focuses students' attention on the questions to be investigated and on what is to be done, observed, interpreted, and reported. It plays a major role in defining goals and procedures. Lunetta and Tamir (1979) developed a set of protocols for analyzing student laboratory activities, which they used to analyze several secondary school science laboratory programs systematically. Similar protocols were used more recently in Australia by Fisher et al. (1999). The analyses continue to suggest that to date, many students engage in laboratory activities in which they follow recipes and gather and record data without a clear sense of the purposes and procedures of their investigation and their interconnections.

In addition, the quantity of information presented in the laboratory guide is often so substantial, according to Johnstone and Wham (1982), that the details can distract the learner from the main goals of the practical task. Consistent with the findings of Lunetta and Tamir (1979) and others, students are seldom given opportunities to use higher-level cognitive skills or to discuss substantive scientific knowledge associated with the investigation, and many of the tasks presented to them continue to follow a "cookbook" approach (Roth, 1994).

2.14 Assessing Students' Laboratory Skills and Understanding of Inquiry

Assessments of students' performance and understanding associated with the science laboratory should be an integral part of the laboratory work of teachers and students. Assessment tools should examine the students' inquiry skills, their perceptions of scientific inquiry, and related scientific concepts and applications identified as important learning outcomes for the investigation or the series of investigations.

In the United States, Doran et al. (1993) developed and validated a test to assess the laboratory skills of students completing high school science courses (chemistry, biology, and physics). Their aim was to develop an authentic and alternative assessment method to measure outcomes of school science programs, including inquiry and activity in the laboratory. In their tests, students had to design an investigation, collect and analyze data, and formulate findings. The students' visual representation and interpretation of their quantitative data was incorporated in the analysis. Using certain criteria, the researchers or teachers unobtrusively observe and rate each student during normal laboratory activities. They assess students according to the following broad phases of activity: (1) planning and design, (2) performance, (3) analysis and interpretation, and (4) application.

Researchers, teachers, and testing jurisdictions whose goal is to assess comprehensively the learning that takes place in school science generally, or in school laboratories more specifically, should use appropriate assessment tools and methodologies to identify what the students are learning (conceptual as well as procedural). The effects of such experiences on students' interest and motivation should also be assessed.

2.15 Teacher Education and Professional Development and Laboratory Use

The school science laboratory continues to be perceived as a unique environment for teaching and learning science in a social setting that includes interactions with materials and data, interactions between and among students, their teacher, and sources of "expert" information. Nevertheless, as noted throughout this review, researchers have continued to observe that many science teachers do not utilize or manage this unique environment effectively.

Many pre-service and in-service courses in science and in science teaching and learning provide very limited direct experience, if any, through which the teachers can develop the skills, needed to organize and facilitate meaningful, practical learning experiences for students in the school science laboratory (Tamir, 1989). Tamir further observed that policy makers often assume that participating in science laboratory work in university courses during their preparation provides them with knowledge and skills sufficient to teach successfully in school science laboratories. While that assumption appears to be widely held, it is not consistent with a growing array of formal and informal data on teachers' conceptual and pedagogical knowledge and teaching practices (Loucks-Horsley and Matsumoto, 1999). Yung (2001) also observed that many teachers lack experience with methods enabling them to assess their students' understanding and performance in the science laboratory. Thus, students' grades often do not reflect their performance in the laboratory work or their understanding of that work. Appropriate long-term professional development is one of the important ways to help teachers develop professional understandings, beliefs, roles, and behaviours (Tobin, 1990).

This study investigates the availability and use of laboratories which will include how equipped they are. The use of the laboratory is also important as equipments in a laboratory will not necessarily translate into good performance but how well the teachers use them in the course of teaching. Practical work therefore enables students to learn manipulative skills, ability to obtain accurate results (data) and use of results (data) to make correct scientific conclusions.

2.16 The Availability and Use of Laboratories Facilities and their Influence on Performance

Based on the findings of a research by Adeyemi (2008), it is concluded that science laboratory is a critical variable in determining the quality of output from secondary schools. The findings show that science laboratory had significant relationship with quality of output from secondary schools. Schools having laboratories in the three science subjects performed best in the examinations out of the three groups of schools with different numbers of science laboratories.

The findings further revealed significant differences in the quality of output among the three groups of schools with different numbers of science laboratories. Schools tend to get better results with more science laboratories thereby agreeing to the findings of previous researchers (Tairab, 1992; Cash, 1993) who reported that school resources such as Science laboratories are strongly related to students` performance while science achievement scores are better in buildings with good science laboratories. The findings were in consonance with Hamide and Geban`s (1996), Greenwald *et al*. (1996) findings

that school facilities such as Science laboratories are related to quality of output from schools. The findings also agreed with Linn (1997) findings that laboratory facilities could improve learning outcomes. The findings were consistent with Alebiosu (2000) and Adeyegbe (2002) findings which attributed the low performance level of students in science subjects in Senior Secondary Certificate (SSC) in Nigeria to, among other things, the inadequacy of science laboratories in schools.

The findings suggest that the choice of schools might perhaps be the same for all students at the time of entering secondary schools while the number of science laboratories in any school which a candidate selected was a predictor of value added. As such, a schools` possession of three science laboratories is a critical factor in performance or a proxy for some other critical factors. This implies that schools with extra laboratories tend to attract bright students. This collaborates with other research made by Onipede (2003), that there were shortages of science laboratory facilities in schools.

2.17 Summary

The review of related literature of the present study considered the main issues in the availability, state and use of laboratories and how they affect students' achievement. From the review, it was established that previous researchers had concentrated more effort on finding the contribution of the learner to his or her own learning challenges. This study attempted to investigate the extent to which laboratory status and use have affected the performance of students in science subjects.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter highlights the proposed research design to be adopted, the target population, sample size, and procedures for selection of such a sample. Also included in the chapter are research instruments and methods employed in data collection and analysis.

3.2 Area of Study

The study was carried out in Trans-Nzoia district, which is one of the many districts in the Rift Valley province. According to the G.O.K, (2002), this district is bordered by the Republic of Uganda to the west, Mt Elgon, Bungoma and Lugari districts to the

southwest, West Pokot to the north, Marakwet to the east and Uasin Gishu to the Southeast. The district has seven administrative divisions that are further subdivided into twenty seven locations and fifty four sub-locations.

The district has three topographical features, namely Mt. Elgon (4313 m) and the Cherangany Hills (3371 m) and the Nzoia River, which flows into Lake Victoria. The district, on average, has a height of 1800 m above sea level, an annual precipitation of 1242mm and a mean temperature of 18.6^0C; however this temperature varies from 10^0C to 30^0C. This gives the district a favourable climate for both farming and livestock production. Sixty percent of the district is arable land mostly owned by satellite farmers and Agriculture Development Corporation. Fifty four percent of the population in Trans-Nzoia lives in absolute poverty (G.O.K, 2002).

The choice of the district for the study was influenced by the limitations in time, effort and funds as Gay (1992) observes. According to Kerlinger (1973), a researcher should be familiar with the research locale, a fact that also influenced the use of Trans-Nzoia district.

3.3 The Target Population

The target population of the study included all the fifty four public secondary schools which had candidates in 2002 in Trans-Nzoia district. The subjects were drawn from these targeted schools and comprised fifty four head teachers, two hundred and seventy one science teachers and fifty four laboratory assistants. Table 3.4.1 gives the summary of target population size.

Table 3.3.1 Target population size

School categories	Number of schools	Subject population			
		Head teachers	Science teachers	Laboratory assistants	Totals
Boys	4	4	37	4	45
Girls	6	6	48	6	60
Mixed	44	44	186	44	274
Totals	54	54	271	54	379

Source: Trans-Nzoia District Education Office (2008).

3.4 Sample and Sampling Procedures

From the above targeted population, forty percent from each category was used in the study that is, twenty two head teachers, twenty two laboratory assistants and one hundred and eight science teachers.

According to Gay (1992), a researcher selects a sample due to various limitations that may not allow researching the whole population. Since science teachers are the ones that work with students in the laboratories and are also responsible in preparing students for examinations in science subjects in their institutions, they were included in the study.

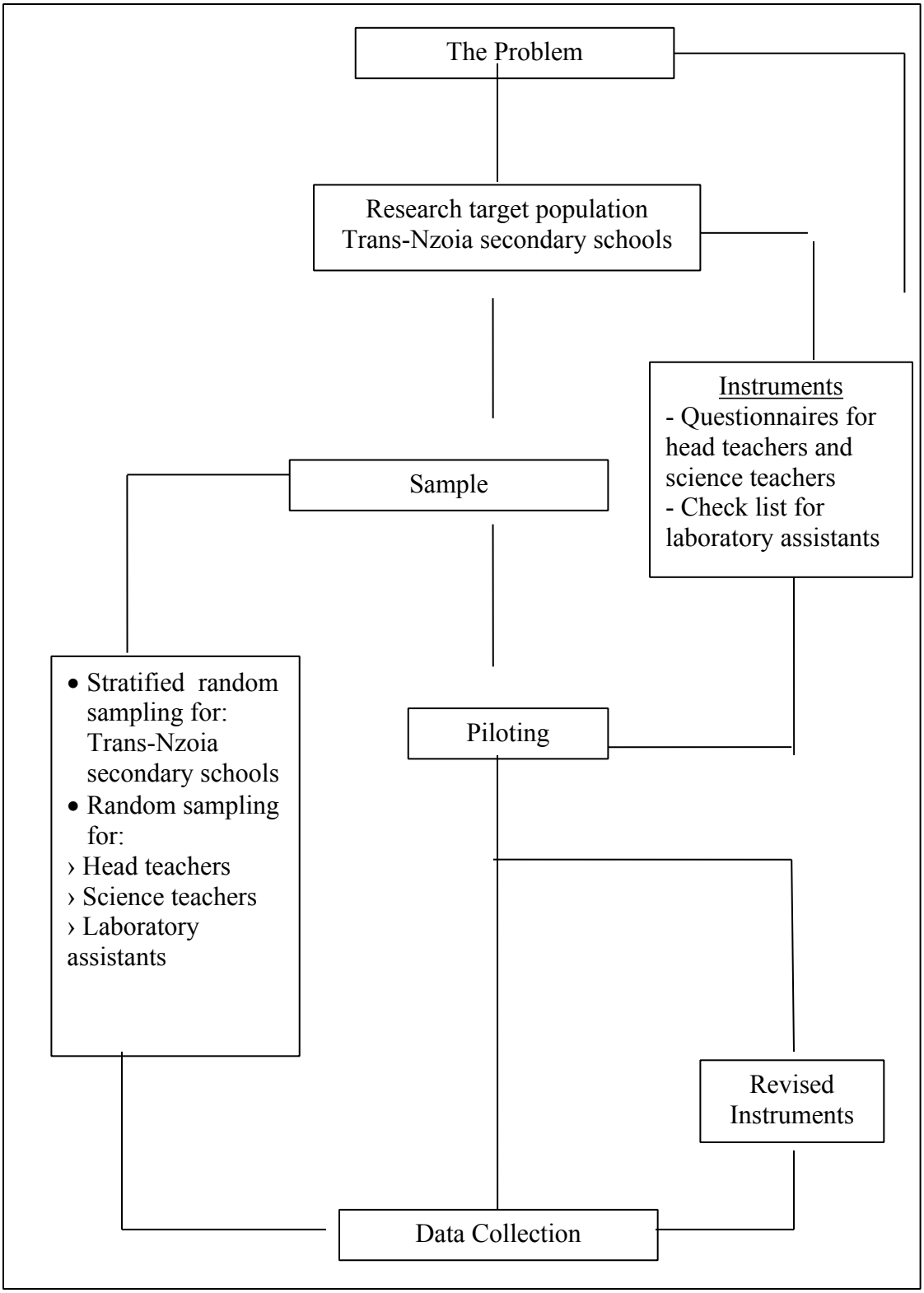
The selection of secondary schools was done through stratified random sampling. A list of all the 54 secondary schools in the district was obtained from the District Education Office, after which they were divided into strata: high achievers; those that have a mean score of above 8.0; average achievers, those with a mean score of between 5.0- 7.99 and low achievers, those with a mean score of less than 5.0. To ensure an appropriate representation of secondary schools in each category and division, stratified random sampling was therefore favoured over simple random sampling.

In addition to the science teachers, all the twenty two head teachers and laboratory assistants of the institutions selected were used in the study. Simple random sampling was used to select one hundred and eight science teachers in at least every selected secondary school. This technique was selected since it is the best single way of obtaining a representative sample. According to Gay (1992) it ensures that every individual has an equal chance of being selected and selection of one individual in no way affects the selection of another one. This enables one to obtain a representative sample for the study.

3.5 Research Design

The study used descriptive survey design to investigate the availability and use of the school laboratory facilities and students' achievements in sciences in secondary schools in Trans-Nzoia district. The research design was chosen because the study involved collecting data in order to test hypotheses or answering questions concerning the current status of the subjects of the study. As observed by Mugenda and Mugenda (1999), descriptive survey determines and reports the way things are. This describes behaviour,

attitudes, opinions, values, perception and characteristics as accurately as possible. It is also used to assess attitudes and opinions about events, individuals or procedures (Gay, 1992). It seeks to identify the nature of factors involved in a given situation, determine the degree in which they exist and discover the links that exist between them. In this case it enabled the researcher to obtain science teachers and head teachers opinions about the laboratory facilities and students achievement in sciences in secondary schools in the district. The advantage of this design is that it is an extremely effective way of gathering information from a large number of sources and in a relatively short time. The method also provides a basis from which predictions are made using other methods of research.



Source: - Adapted from Cohen and Manion (1994)

Figure 3.5.1: Design of the study

3.6 Instruments of the Study

Data was collected during the month of January 2009 after obtaining a permit from the office of the president and permission from the head teachers of the concerned schools. The study mainly utilized:

Questionnaires namely:

- Science teachers' questionnaire on the provision, status and use of the laboratory and how they influence students' performance.
- Head teachers' questionnaire on students' enrolment in science courses in public universities and the provision of laboratory resources.

- An Interview schedule for the laboratory assistants.
- And lastly a check list for the laboratory assistants.

3.6.1 Questionnaires

The questionnaires developed were presented in both structured and unstructured questions. The questionnaires were designed to elicit responses for purposes of statistical analysis. According to Nachmias (1992), the foundation of all questionnaires is the question. The question must translate the research objectives into specific questions; answers to such questions would provide the data for hypothesis testing. The questionnaires were set for twenty two secondary school head teachers and one hundred and eight science teachers who were expected to respond to each questionnaire independently in the spaces provided. The instruments were made effective through the question-sequence, reducing any misconception. Each question was made clear in

relation to the previous questions so that the meaning was readily apparent to the respondent.

3.6.2 Interview schedule

The interview schedule was developed to assist in soliciting information from the laboratory assistants who were interviewed. The method was used to assist in interpreting the meaning of questions where necessary and also allowed for face-to-face contact between the interviewer and the interviewees.

3.6.3 Checklist

A check list was also developed to assist in soliciting information from the laboratory assistants in the selected secondary schools on the status of the laboratories, frequency of use and provision of laboratory resources.

3.7.0 Pilot Study

Between 22nd September and 9th October 2008, a pilot study was conducted to put the instruments to test in order to detect any weaknesses and if questions were clear to the respondents. Four schools in the district were visited where all science teachers, head teachers and laboratory assistants were either interviewed or filled the questionnaire. Problems that arose during the piloting were sorted out by reframing some unclear questions, omitting some questions and merging questions that seemed similar. All the three instruments were found appropriate to obtain responses that would assist answer the objectives of the study.

3.7.1 Validity

Given that content validity is established by expert judgment (Gay, 1992) the instruments were examined and certified by the supervisors who also submitted favourable comments that validated their use for the study. They were relied upon on the content representation on the questions.

3.7.2 Reliability

The questionnaires were also checked for their reliability. Pearson's product moment correlation formula was then applied to estimate the reliability (r) of the total test. To determine the reliability of the questionnaires for the teachers and head teachers, administration of the same instrument to the same group of twenty four teachers and four head teachers twice within an interval of two weeks was done. The relationship between the results obtained from the two occasions was calculated using the Pearson's product moment correlation formula. A reliability coefficient of 0.72 was obtained, which showed the internal consistency of the questionnaire as satisfactory.

3.8.0 Data Collection Procedures

Before the study was undertaken respondents were furnished with information on the purpose of the study before data was collected from all the respondents in sampled institutions. The copies of questionnaires were hand delivered to the heads of institutions. The head teachers in turn organized for the researcher to meet the science teachers and the laboratory assistants of the sampled institutions in order for them to assist in filling the questionnaires and the checklists respectively.

3.8.1 Ethical Considerations

Respondents were assured through a letter at the beginning of the questionnaire, that the information they provided was to be kept private, confidential and anonymous and would not be used for any other purpose apart from this study.

The study was also not biased in terms of gender, religion or tribe during the selection of the respondents. A permit was obtained from the office of the president and permission sought from the school principals in order to conduct the research in their schools.

3.9 Data Analysis

The data collected was edited and coded. A codebook was used to prepare computer code sheet, which was later used to analyse the data. The synthesized data was analyzed both qualitatively and quantitatively. Quantitative analysis involved the use of statistical data in form of frequency distribution tables whose explanation was mainly based on descriptive and inferential statistics. It also examined the statistical significance of the results at $\alpha = 0.05$ level of significance. This analysis was thematically presented in descriptive and inferential way. Quantitative data was analyzed using Chi- square (χ^2). Chi- square test is used in statistical situation requiring testing the capability of the observed and the expected frequencies in a two dimension relationship. Therefore Chi-square was used to determine if there was any relationship between state of laboratory facilities and achievement especially in examination results at KCSE. It was also used to determine if there was any relationship between the number of laboratory sessions and the performance in science subjects.

3.10. Summary

In this chapter, an explanation of the nature of the study and how data was collected has been made. The study was a descriptive design because it determines and reports the way things are, describing behaviour, attitudes, opinions, values, perception and characteristics as accurately as possible. It is also used to assess attitudes and opinions about events, individuals or procedures.

Four research instruments were used to collect data for the study. The questionnaires were used to collect data from the science teachers and head teachers regarding the availability, status and use of laboratories and how they affect students' performance. A check list and an interview schedule for the laboratory assistants were also used to collect data on the same. Data was analyzed both qualitatively and quantitatively with Chi-square being used to test the hypotheses.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

4.1 Introduction

This chapter presents the results of data analysis. The findings are presented in form of frequency distribution tables and percentages. Further analysis involved the use of chi-square to test the hypotheses.

4.2 Form Four Leavers who qualified for Science Courses at the Public Universities between 2002- 2006

An attempt was made to obtain data on Form Four leavers who enrolled for science courses at the public universities over the past five years in Trans-Nzoia district. This data was required in order to establish the availability and use of school laboratory facilities and their influence on students' achievement in science subjects in secondary schools in the district during this period. Data obtained from the head teachers reflected a stagnating trend in the number of students who qualify for science courses at the public university (table 4.2.1). Most of the students who qualified for university studies enrolled for arts based courses. Each year among the sampled schools very few students in the district enrolled for science courses. This therefore, implies that the teaching of science subjects in secondary schools within Trans-Nzoia district is not up to date as expected hence, needs improvement.

Head teachers were asked to give the number of students who attained the cut-off points and were admitted to join public universities to take science courses. Although there are a number of those who pass science subjects but opt for arts based courses, the study chose to use those who join the science based courses. This was so because it is not possible for a student to fail science subjects and then join university to take a science course. Table 4.2.1 presents the results of the findings.

Table 4.2.1: Form Four leavers who joined public universities to take science courses.

School code		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
YEARS	2002	0	1	3	0	3	1	3	15	7	2	13	7	1	2	27	2	5	4	6	3	8	1
	2003	0	3	2	0	5	0	1	14	4	3	15	4	2	2	25	1	4	2	1	3	3	2
	2004	3	2	4	0	2	0	2	18	3	5	11	1	0	1	23	0	3	5	3	4	5	0
	2005	2	4	1	0	4	1	0	21	7	3	13	1	1	3	28	0	4	7	1	2	3	2
	2006	1	2	2	1	2	2	3	13	2	9	16	4	5	2	19	1	5	1	1	5	3	1
Total number of male students.		4	8	9	1	15	0	7	81	15	17	0	17	0	8	122	0	0	14	9	17	17	5
Total number of female students.		2	4	3	0	1	4	2	0	8	5	68	0	9	2	0	3	21	5	3	0	5	1
Total number of students who enrolled for science courses		6	12	12	1	16	4	9	81	23	22	68	17	9	10	122	3	21	19	12	17	22	6
Total number of students who qualified for university between 2002-2006		26	37	42	7	36	14	24	212	49	62	164	54	27	32	512	11	53	49	43	59	71	23
Total number of candidates registered between 2002-2006		292	357	295	311	383	253	303	756	232	205	409	167	142	173	574	161	266	133	178	207	223	132

Maintenance and repair should form an integral part of the routine management of the school plant. This also prevents students' dissatisfaction and unrest. When a school is allowed to deteriorate physically, the human spirit within the school also declines (Sadker and Sadker, 1994). Head teachers were therefore asked to state whether any finances were set aside for repair, improvement and maintenance of existing laboratory facilities in their schools. Table 4.2.2 presents the results of the findings.

Table 4.2.2: Whether any finances were set aside for repair, improvement and maintenance of existing laboratory facilities.

Responses	Frequency	Percent
Yes	17	77.3
No	4	18.2
No Response	1	4.5
Total	22	100

Though most head teachers (77.3%) responded that they always set aside finances for repair, improvement and maintenance, very little was evident on the same from the laboratory assistants responses. A few of the respondents (18.2%) said that head teachers rarely or do not set aside finances for the repair, improvement and maintenance. This implies that laboratories in the schools are neglected and practical lessons are not taken seriously. Some of the head teachers (4.5%) were even non committal on whether they set aside finances for repair, improvement and maintenance or not. This can also imply that in such schools nothing much is going on in the laboratories.

Head teachers were asked to comment on whether good laboratory facilities contribute to good performance of science subjects in their schools. Table 4.2.3 presents the results of findings.

Table 4.2.3: Whether properly maintained laboratory facilities contribute to good performance of science subjects.

Responses	Frequency	Percent
Yes	21	95.5
No	1	4.5
Total	22	100

Repair and maintenance of existing buildings and related facilities requires continued funding to ensure that facilities are maintained in a state of acceptable standards. Schools have control over a significant part of their expenditure and can determine their own educational priorities- repair and maintenance of their laboratories and related facilities. However, it is saddening to discover that long term planning for such repairs and maintenances has largely been ignored and in some institutions development plans for the years ahead are not put in place. This is reflected in the state of their facilities and the usual complaint of limited funds. Despite this, 95.5% of the head teachers responded that good facilities contribute to good performance with only 4.5% feeling that they did not (table 4.2.3).

4.3 Type of School

Head teachers were also asked to state the type of their school, whether it is a mixed day/ boarding school, single sex boarding or mixed day. Table 4.3.1 presents the results of the findings.

Table 4.3.1: Type of school.

	PERCENTAGES			
Type of school / School mean	Mixed day/ boarding	Single sex boarding	Mixed day	Totals
Above 8.0	0	13.6	0	13.6
5.0- 7.99	9.1	4.5	18.2	31.8
Less than 5.0	4.5	9.2	40.9	54.6
Totals	13.6	27.3	59.1	100

From table 4.3.1 it can be observed that among schools with achievement mean of above 8.0, single sex schools (13.6%) perform better than the mixed day/ boarding (0%) and mixed day schools (0%). Studies by Lee and Bryll (1986) show that, boarding schools on average perform better than mixed boarding and mixed day schools. It can further be observed that among schools with an achievement mean of less than 5.0, mixed day contribute the majority (40.9%) which is an implication that day schools do not post good results in KCSE within Trans-Nzoia district.

Head teachers were asked to comment on the status of their schools; whether they were district or provincial school. Table 4.3.2 presents the results of the findings.

Table 4.3.2: Status of the school

	PERCENTAGES		
Type of school / School mean	District school	Provincial school	Totals
Above 8.0	0	13.6	13.6
5.0- 7.99	27.2	9.2	36.4
Less than 5.0	50.0	0	50.0
Totals	77.2	22.8	100

From table 4.3.2, it can be shown that provincial schools perform better than district schools. Due to the high number of district schools and considering the criteria used in form one selection and admission, this then implies that the majority of students in the district are average in performance and there for this calls for more practical work to assist the average students to conceptualize concepts in sciences easily. Thus there is need for well equipped laboratories and their frequent use.

4.4: Teachers' Responses on which Subject they teach

Teachers' were asked to state the kind of subjects they teach in their respective schools. Table 4.4.1 presents the results of the findings.

Table 4.4.1: Subjects taught by the teachers

Subjects	Frequency	Percent
Biology	49	45.4
Chemistry	39	36.1
Physics	20	18.5
Total	108	100

From table 4.4.1 it can be observed that biology has more teachers in the district (45.4%) as compared the other science subjects, chemistry (36.1%) and physics (18.5%). This could explain the reason why biology as a subject had the best mean score when compared to the other two science subjects for the last five years, though it was the least stocked in terms of facilities when compared to the other science subjects. This implies that the other science subjects, chemistry and physics, are not taking advantage of their relatively well stocked laboratories to perform better than biology. It seems the laboratories are being under utilized by the teachers and students in practical work.

Teachers were also asked to rate their students performance in science subjects. Table 4.4.2 presents the results of the findings.

Table 4.4.2: Students' performance rating in sciences subjects

Responses	Frequency	Percent
Very good	4	3.7
Good	43	39.8
Average	49	45.4
Below average	11	10.2
No response	1	0.9
Total	108	100.0

According to the teachers interviewed many of them rated their students as average performers (45.4%) in science subjects. A good number also felt that their students were good (39.8%). Only 10.2% rated their students as below average while 3.7% rated them as very good. This implies that the entry behaviour of students to candidate classes is not below average hence if practical lessons are emphasized they can do well in national examinations. Thus teachers need to be sensitized on the need to undertake practical work seriously and do more practicals in science subjects with the students.

4.5: Laboratory and its Use

Teachers' response was sought to determine whether their schools had a laboratory/ laboratories. Table 4.5.1 presents a data on how the teachers responded to the question.

Table 4.5.1: Availability of a laboratory

Responses	Frequency	Percent
Yes	98	90.7
No	7	6.5
No Response	3	2.8
Total	108	100

Most of the schools visited on average tended to have a laboratory/ laboratories. According to table 4.5.1, a majority (90.7%) of the schools indicated that they had a structure they termed as a laboratory. Only a few (6.5%) said they did not have a laboratory. Laboratories are an essential part for good performance in science subjects by the students and hence schools need these structures to carry out practical lessons. It is therefore, apparent that most schools have a laboratory/ laboratories and laboratory lessons can take place in most of the schools if apparatus and chemicals are provided by the school administration.

Teachers were asked to specify if the laboratory/ laboratories were discipline specific. Table 4.5.2 presents the results of the findings.

Table 4.5.2: Laboratory status by specific subject discipline

Responses	Frequency	Percent
Yes	52	48.1
No	52	48.1
No Response	4	3.8
Total	108	100

Table 4.5.2 shows that about half (48.1%) of the schools indicated that they had laboratories, which were discipline specific with the same percentage of schools indicating that they had laboratory/ laboratories that were jointly used by different disciplines. The average number of laboratories per school was two, which though, hides disparities among the schools in terms of the numbers and equipping of the laboratories. For instance, there were schools with no laboratories while others had as many as three.

Despite the disparities between the numbers of laboratories per school, it is evident that majority of the schools have laboratories and therefore, laboratory practical sessions can take place. Thus, the schools within the district should put more emphasis in practical sessions in order to improve the performance of science subjects and by doing so increase the number of students who join universities to take science based courses.

To find out on whether laboratory/ laboratories are enough for all science subjects the teachers were asked to state whether they considered the laboratories in the school enough for all the science subjects. Table 4.5.3 presents the results of the findings.

Table 4.5.3: Assessment on whether laboratory/ laboratories are enough for all science subjects.

Responses	Frequency	Percent
Yes	38	35.2
No	68	63.0
No Response	2	1.8
Total	108	100

The uniqueness of the laboratory lies principally in providing students with opportunities to engage in processes of investigation and inquiry but despite this, majority of the schools were found not to have enough laboratories for all the students in all the three sciences. According to table 4.5.3, a significant number (63.0%) of the teachers interviewed felt that the numbers of laboratories in their schools were not enough; since they had a large number of students. Therefore, learning that involves practical work could not be carried out properly since some students miss out on laboratory sessions. This to a certain extent explains why the performance of science subjects is below average. There is need therefore, to put up more laboratories to enhance practical work in order to raise the performance of students in this district.

Teachers were also asked to state the frequency at which they conducted practical lessons in the science subjects. Table 4.5.4 presents the results of the findings.

Table 4.5.4: Frequency of conducting practical lessons

School achievement level (Mean Score)	More frequently	Frequently	Rarely	Very rarely	Total
Above 8.0	7	12	0	0	19
5.0- 7.99	9	24	0	0	33
Less than 5.0	4	44	5	3	56
Total	20	80	5	3	108
Percentage	18.5	74.1	4.6	2.8	100

Though most teachers interviewed carried out practical lessons quite frequently (74.1%), a number of them rarely (4.6%) or very rarely (2.8%) carried them out (table 4.5.4). This could lead to poor performance in the examinations since students require laboratory skills in order to make observations; review what is already known in light of experimental evidence; use tools to gather, analyze, and interpret data; propose explanations and predictions; and communicate the results. All these are essential in the national examinations Paper 3 (practical paper) in the science subjects.

From the table 4.5.4, it is also apparent that schools, which rarely or very rarely carried out practicals, always scored a very low mean grade in their national examinations. All those schools that rarely or very rarely carried out practicals had a mean score of less than 5.00.

This shows that practical work in science subjects contributes a lot to good performance of a school.

Teachers were also asked to comment on type of experiment they most frequently use in their schools. Table 4.5.5 presents the results of the findings.

Table 4.5.5: Type of experiment most frequently used

Responses	Frequency	Percent
Group experiments	88	63.8
Teacher demonstrations	49	35.5
No response	1	0.7
Total	138	100

N.B Responses are more than respondents because of the multiple-choice responses (N=108)

Another observation made during the study was that though the majority of teachers did carry out practical lessons most frequently (18.5%) or frequently (74.1%) as shown in table 4.5.4, most of the practical lessons carried out by the teachers interviewed were group experiments (63.8%) and teacher demonstrations (35.5%) (table 4.5.5). These methods of doing practical work are less student centered and deny students a chance to enhance their understanding of scientific concepts. They are also deprived off opportunity to develop interest and motivation, scientific practical skills and problem solving abilities, scientific habits of mind and understanding of the nature of science. Laboratory

experiences are therefore, very important for a student to perform well in science subjects' examinations.

Teachers were also asked to give reasons for carrying out group experiments and teacher demonstrations in their schools. Table 4.5.6 presents the results of the findings.

Table 4.5.6: Reasons for carrying out group experiments and teacher demonstrations.

Responses	Frequency	Percent
Lack of apparatus	60	55.6
Lack of chemicals	9	8.3
Lack of practical manuals	7	6.5
Save on time	25	23.1
Lack of reference books	1	0.9
No response	6	5.6
Total	108	100

Most teachers expressed their desire and willingness to carry out practical lessons that students would be able to handle and / or manipulate the apparatus on their own. But due to certain factors such as lack of apparatus (55.6%), saving on time (23.1%), lack of chemicals (8.3%) among others, hinders them from doing so (table 4.5.6). This implies that the students are deprived of the necessary skills to be able to carry out an experiment on their own hence hindering them from performing well in national examinations in the

sciences. Some teachers emphasized teaching techniques that are less aligned with students' ability to earn high grades, hence the use of group experiments and teacher demonstrations in the absence of apparatus and chemicals and on saving time.

4.6: Laboratory Use and Its Influence on Students' Performance in the Science Subjects

Teachers were also asked to comment on how laboratory apparatus has influenced performance in sciences in their schools. Table 4.6.1 presents the results of the findings.

Table 4.6.1: How laboratory apparatus have influenced performance in sciences.

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	8	11	0	0	0	19
5.0- 7.99	8	14	9	2	0	33
Less than 5.0	12	17	16	7	4	56
Total	28	42	25	9	4	108
Percentage	25.9	38.9	23.2	8.3	3.7	100

It was observed that although laboratories were in many schools visited, and they were also acknowledged as conventional locations for teaching and learning process, little concern and appreciation is given to this important resource. Lack of enough apparatus has strongly affected the students negatively. This corroborates with all the respondents

(19 out of 19) in the schools with a mean above 8.0 who felt strongly or very strongly that lack of apparatus affects the performance of students in science subjects. According to table 4.6.1, many teachers interviewed felt that lack of apparatus very strongly (25.9%) or strongly (38.9%) affected the students' performance in sciences. Only 8.3% of the respondents felt that lack of apparatus did not affect the students' performance in science subjects. This, therefore, underlines the importance of a well equipped laboratory, which should be constantly used by the students in practical work.

Teachers were asked to comment on the influence of laboratory teaching aids on performance of students in science subjects in their schools. Table 4.6.2 presents the results of the findings.

Table 4.6.2: Influence of laboratory teaching aids on performance of students in science subjects.

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	6	11	1	0	1	19
5.0- 7.99	10	11	7	2	3	33
Less than 5.0	6	21	24	4	1	56
Total	22	43	32	6	5	108
Percentage	20.4	39.8	29.6	5.6	4.6	100

Teachers were also asked to state their opinion on how the availability of the laboratory teaching aids has affected the teaching- learning process during laboratory sessions. According to table 4.6.2, it is apparent that lack of enough teaching aids has very strongly (20.4%) or strongly (39.8%) affected the students negatively. Only 29.6% of the teachers felt that it has averagely affected them while 5.6% felt it had no effect and they could do without them. A majority (17 out of 19) of the respondents in schools with a mean above 8.0, felt strongly or very strongly that lack of enough laboratory teaching aids has affected the performance of students in science subjects.

Teachers were also asked to comment on the influence of enough laboratory chemicals on performance of students in sciences subjects in their schools. Table 4.6.3 presents the results of the findings.

Table 4.6.3: Influence of enough laboratory chemicals on performance of students in sciences subjects

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	2	15	0	1	1	19
5.0- 7.99	8	8	13	0	4	33
Less than 5.0	18	17	12	9	0	56
Total	28	40	25	10	5	108
Percentage	25.9	37.0	23.2	9.3	4.6	100

Lack of enough chemicals has affected the performance of students in science subjects. This premise is supported mostly by teachers in schools with a mean score above 8.0. A majority, 17 out of 19 of the respondents in schools with a mean above 8.0, felt strongly or very strongly that lack of enough laboratory chemicals has affected the performance of students in science subjects. As summarized in table 4.6.3, 25.9% of the teachers felt very strongly that lack of enough chemicals in the laboratory has affected negatively the performance of students in the national examinations with 37.0% feeling strongly about the same. Only 23.2% felt that it has averagely affected them and 9.3% observed that it had no effect at all on the performance of students in science subjects.

Teachers were asked to comment on the influence of enough laboratory furniture on performance of students in sciences subjects in their schools. Table 4.6.4 presents the results of the findings.

Table 4.6.4: Influence of enough laboratory furniture on performance of students in sciences subjects.

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	1	16	1	1	0	19
5.0- 7.99	3	13	14	3	0	33
Less than 5.0	6	6	26	12	6	56
Total	10	35	41	16	6	108

Percentage	9.3	32.4	37.9	14.8	5.6	100

Furniture in the laboratory is essential to a students comfort and attitude towards laboratory practical sessions. Enough furniture makes all the students who visit the laboratory during practical sessions want to take more time in the laboratory than when the furniture is not there or is not enough for all the students. Despite the importance of furniture in a laboratory, lack of enough furniture did not have a big influence on students' performance in science subjects when compared to the shortage in laboratory apparatus (table 4.6.1) and chemicals (table 4.6.2). On furniture, as observed in table 4.6.4, the highest percentage of teachers, 37.9%, felt that it has averagely affected the performance of the students. 9.3% very strongly felt that furniture in laboratory has affected the students' performance with 32.4% strongly feeling the same. 14.8% of the teachers felt it had no influence at all.

Teachers were asked to comment on the influence of laboratory management on performance of students in sciences subjects in their schools. Table 4.6.5 presents the results of the findings.

Table 4.6.5: Influence of laboratory management on performance of students in sciences subjects

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	4	7	6	1	1	19

5.0- 7.99	6	9	14	3	1	33
Less than 5.0	3	24	7	20	2	56
Total	13	40	27	24	4	108
Percentage	12.0	37.0	25.1	22.2	3.7	100

On average it is observed that the management of the laboratory/ laboratories had much effect on the performance of the students in the science subjects. According to table 4.6.5, 22.2% of the respondents felt it had no effect while 25.1% felt it averagely affected the students' performance. A good number also felt that the management of the laboratory/ laboratories had very strong or a strong effect on the students' performance. From the table, 37.0% of the respondents felt that it strongly affected them while 12.0% felt that it very strongly affected them. It can also be observed that the majority of the respondents who support the idea that laboratory management averagely or has no effect on performance (27 out of 56) come from schools with a mean score of below 5.00. It was also revealed that those who very strongly or strongly support the idea that laboratory management averagely or has no effect on performance (24 out of 52) come from schools with a mean above 5.00. It is therefore, apparent that lack of laboratory management affects the performance of students in science subjects.

Teachers were also asked to comment on the influence of the number of laboratory sessions on performance of students in sciences subjects in their schools. Table 4.6.6 presents the results of the findings.

Table 4.6.6: Influence of the number of laboratory sessions on performance of students in sciences subject.

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	15	3	1	0	0	19
5.0- 7.99	9	10	11	3	0	33
Less than 5.0	2	26	15	5	8	56
Total	26	39	27	8	8	108
Percentage	24.1	36.1	25.0	7.4	7.4	100

Laboratory work is an important medium for enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science. Lack of enough laboratory sessions tends to make students have a negative attitude towards science since their interest in science is less stimulated. According to table 4.6.6, it is apparent that lack of enough laboratory sessions for students affects their performance in KCSE examinations. Teachers very strongly (24.1%) and strongly (36.1%) felt that lack of enough laboratory sessions for students tends to make them under perform in science subjects in the national examinations. From the table it can also be noted that 25.0% of the teachers felt that the number of laboratory sessions averagely affects them while 7.4% felt it does not affect them.

The hypothesis HO_2 was tested using Chi square distribution and presented in table 4.6.7.

Table 4.6.7: Results of Chi-square test on the relationship between laboratory sessions and students' achievement (Test Statistics)

	Influence of number of laboratories sessions on the performance of science subjects.
Chi-Square (χ^2)	96.658
Degree of freedom (df)	4
Asymp. Sig.	.000

0.0% has expected frequencies less than 5. The minimum expected cell frequency is 60.8.

Chi - square was also used to test whether there is any significant relationship between laboratory sessions and students' achievement. The results of the chi-square test in table 4.6.7 show that, the computed value (96.658) is greater than the critical value (9.488) at 0.05 level of significance ($\chi^2(4) = 96.658$, $\rho < .05$) hence rejecting the null hypothesis. This implies that the null hypothesis, which stated that there is no significant relationship between laboratory sessions and students' achievement, is rejected. Laboratory sessions influence students' achievement.

Teachers were also asked to comment on the influence of the number of laboratory/ laboratories on performance of students in sciences subjects in their schools. Table 4.6.8 presents the results of the findings.

Table 4.6.8: Influence of the number of laboratory/ laboratories on performance of students in sciences subjects.

School achievement level (Mean Score)	Very strongly	Strongly	Average	No effect	No response	Total
Above 8.0	2	14	3	0	0	19
5.0- 7.99	12	17	2	2	0	33
Less than 5.0	8	1	31	9	7	56
Total	22	32	36	11	7	108
Percentage	20.4	29.6	33.3	10.2	6.5	100

Lack of enough laboratories for students practical sessions in science subjects has affected the performance of students. Most schools had an average of two laboratories (table 4.7.1), which was not enough for the three sciences offered in the schools. Teachers had to do without a laboratory at times and hence deny students a chance to enhance their practical skills. This had a big impact on their performance in the national examinations that resulted in low scores. This collaborates with the responses of teachers interviewed (table 4.6.8) whereby 20.4% very strongly felt that lack of enough laboratories affected students' performance in the national examinations. 29.6% of the teachers strongly felt the same with only 10.2% feeling that it did not have any effect. Slightly over a third (33.3%) of the teachers felt that lack of enough laboratories averagely affected students' performance in the national examinations.

The hypothesis HO_3 was tested using Chi-square distribution presented in table 4.6.9

Table 4.6.9: Results of Chi-square test on the relationship between the provision of laboratory facilities and students' achievement.

	Influence of the provision of laboratory facilities on students' achievement in science subjects.
Chi-Square(χ^2)	264.697
Degree of freedom (df)	5
Asymp. Sig.	.000

0.0% has expected frequencies less than 5. The minimum expected cell frequency is 50.7.

Chi - square was used again to test whether there is any significant relationship between the availability of laboratory facilities and students' achievement. The results of the chi-square test in table 4.6.9, shows that the computed value (264.697) is greater than the critical value (11.071) at 0.05, level of significance. (χ^2 (5) = 264.697, $\rho < .05$) hence rejecting the null hypothesis. This implies that the null hypothesis stating that there is no significant relationship between the availability of laboratory facilities and students' achievement is rejected. Availability of laboratory facilities influences students' achievement.

Teachers were also asked to state the science subject that had the highest mean score in their school during the five year period (2002- 2006). Table 4.6.10 presents the results of the findings.

Table 4.6.10: Science subject that had the highest mean score.

Year	Chemistry	Physics	Biology
2002	12.0%	12.0%	58.3%
2003	2.8%	23.1%	57.4%
2004	9.3%	39.8%	36.0%
2005	4.6%	34.3%	47.2%
2006	4.6%	40.7%	41.7%
Average	6.66%	29.98%	48.14%

During the five year period (2002-2006) biology had the highest mean score (48.14%) followed by physics (29.98%) and the last was chemistry (6.66%), (table 4.6.10). Physics and chemistry laboratories require a lot of equipments and chemicals as opposed to biology laboratory. Most of the equipments in chemistry are expensive and fragile thus require a lot of money to buy. Most of the chemicals for chemistry are consumables and need constant replenishment, which makes the facilitation difficult when funds are not forthcoming. Data collected from the check lists (table 4.8.1) illustrated that most laboratories had just the basic minimum of the equipments. This therefore, explains why performances in physics and chemistry are much lower than in biology.

4.7 State of Laboratories and their Influence on Students Performance

The social environment in a school laboratory is usually less formal than in a conventional classroom. Thus, the laboratory offers opportunities for productive, cooperative interaction among students and with the teacher that has the potential to promote an especially positive learning environment. The learning environment depends markedly on the nature of the activities conducted in the laboratory, the expectations of the teacher (and the students), and the nature of assessment. It is influenced by the materials, apparatus, resources, and physical setting, which led to finding out the state of laboratory/ laboratories and their influence on students' performance.

Teachers were also asked to state the number of laboratories in respective schools. Table 4.7.1 presents the results of the findings.

Table 4.7.1: Number of laboratories in respective schools.

Number of laboratories	Frequency	Percent
1	28	25.9
2	29	26.9
3	38	35.2
0	4	3.7
No response	9	8.3
Total	108	100

The study revealed that most schools had less than three laboratories which are not enough for the three science subjects. According to table 4.7.1, 25.9% of the schools visited had only one laboratory while 26.9% of the schools had two laboratories. It can also be noted that 52.8% of the schools had less than three laboratories, an indication that laboratories are not adequate for the science subjects. Only 35.2% of the schools visited had three laboratories, which meant that each science subject had its own laboratory. To make matters even worse, 3.7% of the schools visited had nothing they could call a laboratory.

Teachers were also asked to state the whether the laboratories were complete or incomplete in terms of furnishing and construction in their respective schools. Table 4.7.2 presents the results of the findings.

Table 4.7.2: Complete or incomplete laboratories.

Responses	Frequency	Percent
Complete	33	30.6
Incomplete	61	56.4
No response	14	13.0
Total	108	100

It was also noted (table 4.7.2) that most of the laboratories though short in the required number; they were also incomplete. From this table, 56.5% of the respondents observed that laboratories were incomplete with only 30.6% of them responding that laboratories

were complete. However, a small number (13.0%) of the respondents were silent on whether they were complete or did not give any response to the question.

Teachers were also asked to state the laboratory with the highest number of facilities in their respective schools. Table 4.7.3a presents the results of the findings.

Table 4.7.3a: Laboratory with the highest number of facilities in school.

Responses	Frequency	Percent
Chemistry	78	72.2
Physics	7	6.5
Biology	7	6.5
No response	16	14.8
Total	108	100

From table 4.6.10, many teachers (72.2%) pointed out that chemistry laboratory was the most equipped compared to the others but chemistry still performed poorly compared to biology, which is not well equipped. Only a paltry 6.5% of the respondents felt that biology was the most equipped with physics having the same response, (table 4.7.3a). This implies that chemistry does not make full use of the facilities available.

Teachers were also asked to state the proportion of students who took all the three sciences in form four in their respective schools. Table 4.7.3b presents the results of the findings.

Table 4.7.3b: Proportion of students who took all the three sciences in Form Four

Proportion of students %	2002	2003	2004	2005	2006	Average %
Less than 25.0	49.1	41.7	27.4	26.9	29.6	34.9
25.0 - 50.0	21.3	27.8	37.0	33.3	26.9	29.3
50.0- 75.0	9.3	11.1	15.7	20.4	18.5	15.0
Greater than 75.0	12.0	12.0	12.0	13.9	20.4	14.1
No response	8.3	7.4	7.4	5.6	4.6	6.7

It can be observed from the trend in table 4.7.3b that the biggest percentage of students did not take all the three sciences within the schools in the district. An average percentage of 14.1% took the entire three science subjects within the five years (2002-2006). On average, most of the respondents (64.2%) indicated that less than 50% of the students took all the three science subjects within the period of five years which is a worrying trend to standards of the district in these subjects. Only an average of 29.1% of the respondents indicated that they had above 50% of their students taking all the three science subjects. This implies that schools are not well equipped or do not have enough

laboratory facilities hence the number of students opting for the three sciences is less than 50%.

Teachers were also asked to state whether there is space adequate space for all the students in the laboratory/ laboratories during a practical lesson in their respective schools. Table 4.7.4 presents the results of the findings.

Table 4.7.4: Availability of adequate space for students in the laboratory/ laboratories during a practical lesson.

Responses	Frequency	Percent
Yes	40	37.0
No	64	59.3
No Response	4	3.7
Total	108	100

Since creating a healthy learning environment is an important goal for many contemporary science educators, it was necessary to find out whether the laboratories had enough space to accommodate a whole class during a practical lesson. According to table 4.7.4, 59.3% of the respondents felt that the laboratories do not have adequate space for all the students during a practical lesson while only 37.0% felt that the space is enough. This implies that the teaching-learning process during a practical lesson is affected negatively.

Teachers were also asked to state whether laboratories have sufficient apparatus/chemicals in their respective schools. Table 4.7.5 presents the results of the findings.

Table 4.7.5: Laboratory/ laboratories having sufficient apparatus/chemicals.

Responses	Frequency	Percent
Yes	28	25.9
No	76	70.4
No Response	4	3.7
Total	108	100

The study further sought to find out whether the laboratory/ laboratories had enough chemicals/ apparatus. The teachers interviewed observed that the laboratory/ laboratories lacked enough chemicals/ apparatus. According to this table, 70.4% responded that their school laboratory/ laboratories lacked enough chemicals/ apparatus while only 25.9% observed that they had enough.

Teachers were also asked to state whether laboratories were adequate in their respective schools. Table 4.7.6 presents the results of the findings.

Table 4.7.6: Adequacy of laboratories

Responses	Frequency	Percent
Adequate	21	19.4
Inadequate	85	78.7
No response	2	1.9
Total	108	100

It was also observed that the number of laboratories was not enough to cater for the total student population in the schools visited. Many teachers interviewed felt that the number of laboratories in their schools was inadequate (78.7%) and only a small percentage (19.4%) felt it was adequate (table 4.7.6).

Teachers were also asked to rate the laboratory assistants and their capability of handling laboratory assignments in their schools. Table 4.7.7 presents the results of the findings.

Table 4.7.7: Laboratory assistants rating and handling of laboratory assignments

Responses	Frequency	Percent
Yes	89	82.4
No	8	7.4
No Response	11	10.2
Total	108	100

Most schools had laboratory assistants who were qualified to handle laboratory assignments. According to table 4.7.7, 82.4% of the respondents felt that their schools had enough laboratory assistants who were qualified to perform laboratory work. Only 7.4% of the teachers interviewed felt otherwise. This implies that teachers could be motivated to undertake laboratory sessions as they have personnel who are able to assist in preparing laboratory lessons.

Teachers were also asked to comment on the adequacy of the laboratory furniture in their schools. Table 4.7.8 presents the results of the findings.

Table 4.7.8: Laboratory furniture

Responses	Frequency	Percent
Adequate	46	42.6
Inadequate	60	55.6
No response	2	1.8
Total	108	100

Most laboratories in the schools visited lacked furniture. According to table 4.7.8, 55.6% of the teachers interviewed felt that the furniture present in the laboratory/ laboratories in their schools was inadequate and only a small percentage (42.6%) felt it was adequate. This brings discomfort among the students during practical lessons hence negatively impacting by reducing their interest in science subjects.

Teachers were also asked to comment on frequency of purchasing/ repairing laboratory facilities by the school administration in their schools. Table 4.7.9 presents the results of the findings.

Table 4.7.9: Frequency of purchasing/ repairing laboratory facilities by the school administration

Responses	Frequency	Percent
More frequently	11	10.2
Frequently	66	61.1
Rarely	26	24.1
Very rarely	5	4.6
Total	108	100

Repair and maintenance of existing buildings and related facilities is not only a legal requirement but, as observed by Thomas and Simkins (1987), a legal obligation. This area requires continued funding to ensure that fine facilities are maintained in a state of acceptable standards. Schools have control over a significant part of their expenditure and can determine their own educational priorities- repair and maintenance of their buildings and related facilities. This corroborates with the teachers' response where 61.1% of them

responded that the school administration frequently buys/ repairs laboratory facilities. Some teachers responded that the school rarely (24.1%) buys/ repairs laboratory facilities with only 4.6% responding that it very rarely does so (table 4.7.9).

Teachers were also asked to comment on the state of laboratories in their schools. Table 4.7.10 presents the results of the findings.

Table 4.7.10a: State of laboratories

Responses	Frequency	Percent
Excellent	2	1.9
Good	31	28.7
Fair	53	49.0
Poor	7	6.5
No response	15	13.9
Total	108	100

In finding out the state of the laboratories, the results of table 4.7.10 show that majority (49.1%) of the teachers interviewed felt that the state of their laboratory/ laboratories was fair with 1.9% and 28.7% feeling they were in excellent and good state respectively. However, 6.5% of the respondents felt that the laboratories were in a poor state. This may

partly explain the reason why students perform poorly in science subjects since the majority of the teachers do not regard their laboratories as good or excellent for teaching.

The hypothesis HO_1 was tested using Chi-square distribution presented in table 4.7.10b

Table 4.7.10b: Results of Chi-square test on the relationship between the state of laboratories and students' achievement in science subjects.

	State of laboratories and students' achievement in science subjects.
Chi-Square(χ^2)	220.671
Degree of freedom (df)	4
Asymp. Sig.	.000

0.0% has expected frequencies less than 5. The minimum expected cell frequency is 60.8.

Chi - square was used again to test whether there is any significant relationship between the state of laboratories and students' achievement in science subjects. The results of the chi-square test in table 4.7.10b, shows that the computed value (220.671) is greater than

the critical value (9.488) at 0.05 level of significance, (χ^2 (4) = 220.671, $\rho < .05$) hence rejecting the null hypothesis. This implies that the null hypothesis stating that there is no significant relationship between the state of laboratories and students' achievement in science subjects is rejected. The state of laboratory facilities therefore, influences students' achievement in science subjects.

Teachers were also asked to comment on how the adequacy of laboratory facilities affects performance of students in sciences subjects in their schools. Table 4.7.11 presents the results of the findings.

Table 4.7.11: Adequacy of laboratory facilities and its effect on performance.

Responses	Frequency	Percent
Strongly disagree	1	0.9
Disagree	22	20.4
Undecided	6	5.6
Agree	32	29.6
Strongly agree	45	41.7
No response	2	1.8
Total	108	100

Gunstone and Champagne (1990) suggested that meaningful learning in the laboratory would occur if students were given sufficient time and opportunities for interaction and reflection. They further observed that if students did not have time or opportunity to

interact and reflect on central ideas in the laboratory then they will have a lower ability in expressing themselves during national examinations. Hence, lack of enough facilities strongly affects their performance in science subjects. According to table 4.7.11, 41.7% of the teachers strongly agreed while 29.6% agreed that lack of enough facilities affected the performance of students in science subjects. Of those teachers interviewed only 20.4% of them disagreed.

Teachers were also asked to state whether adequate practical manuals for all the students in their respective schools. Table 4.7.12 presents the results of the findings.

Table 4.7.12: Adequacy of students' practical manuals

Responses	Frequency	Percent
Adequate	22	20.4
Inadequate	84	77.8
No response	2	1.8
Total	108	100

Doing practical work is appealing to students, but only when the procedure involved is understood before the practical session, hence the need of students' practical manual. From table 4.7.2 most teachers, 77.8% observed that the practical manuals were inadequate with only 20.4% indicating that they were enough. This causes confusion to students during a practical session due to lack of proper instructions to guide them.

Teachers were also asked to state whether adequate reference books in science subjects in their respective schools. Table 4.7.13 presents the results of the findings.

Table 4.7.13: Adequacy of reference books

Responses	Frequency	Percent
Adequate	29	26.9
Inadequate	77	71.3
No response	2	1.8
Total	108	100

From table 4.7.13, it is evident that most teachers (71.3%) felt that reference books are not adequate. This confirms the earlier finding that lack of facilities was one major problem affecting students' performance in science subjects. Teachers also felt that the schools must exemplify efficiency by purchasing more laboratory facilities in order to increase the students' performance in science subjects in secondary schools in the district.

One observed feature that could not be ignored in the study was that of whether upgrading of laboratory facilities will attract more science students. The presence of low quality laboratory facilities had an implication on the performance of students in science subjects in secondary schools. Teachers were therefore asked to state whether upgrading of laboratory facilities attracts more students to take sciences in their respective schools. Table 4.7.14 presents the results of the findings.

Table 4.7.14: Whether upgrading of laboratory facilities attracts more students to take sciences.

Responses	Frequency	Percent
Strongly disagree	3	2.8
Disagree	7	6.5
Undecided	1	0.9
Agree	31	28.7
Strongly agree	64	59.3
No response	2	1.8
Total	108	100

From table 4.7.14, it can be observed that many teachers (59.3%) strongly agreed that upgrading of laboratory facilities will attract more science students while only 2.8%

strongly disagreed and 6.5% disagreed with the idea. It can be further observed that 28.7% of the teachers interviewed were in agreement that upgrading of laboratory facilities will attract more science students. This implies that lack of laboratory facilities has forced quite a number of students in the district to take the minimum number of science subjects (two) other than the three on offer.

4.8: Checklist for Laboratory Assistants

According to table 4.8.1, most of the schools showed that they had most of the items in the checklist but the problem was that they were not enough. This shows that the few items that are in these schools are strained in terms of usage. Students in most schools compete to use the few laboratory apparatus that are available hence; most of them do not spend enough time with the apparatus to enhance the skills necessary for practical subjects. Practical work enables students to learn manipulative skills, ability to obtain accurate results (data) and use of results (data) to make correct scientific conclusions and hence a need for a well equipped laboratory.

Table 4.8.1: Checklist for laboratory assistants on the status of the laboratories.

	Response	percentages	Response	percentages		Response	percentages	Response	percentages
ITEM	**YES**	**%**	**NO**	**%**		**ENOUGH**	**%**	**NOT ENOUGH**	**%**
CHEMISTRY									
Conical flasks	22	100	0	0		7	31.8	15	68.2
Beakers	22	100	0	0		22	100	0	0
Bunsen Burners and wire gauze	22	100	0	0		22	100	0	0
Kipps gas generator	5	22.7	17	77.3		2	9.1	20	90.9
Burettes	22	100	0	0		7	31.8	15	68.2
Pipettes	22	100	0	0		7	31.8	15	68.2
Chemical balance	1	4.5	21	95.5		1	4.5	21	95.5
Round/ Flat bottomed flasks	7	31.8	15	68.2		5	22.7	17	77.3
Funnels	13	59.1	9	40.9		5	22.7	17	77.3
Glass trough	6	28.3	16	72.7		2	9.1	20	90.9
Thermometers	22	100	0	0		7	31.8	15	68.2
Crucibles	18	81.8	4	18.2		12	50	12	50
Retort stands, clamps , Tripod stand	22	100	0	0		5	22.7	17	77.3
Desiccators	6	28.3	16	72.7		4	18.2	18	81.8
Mortar and Pestle	5	22.7	17	77.3		1	4.5	21	95.5
Combustion tubes, deflagrating spoon	2	9.1	20	90.9		5	22.7	17	77.3
Cork borers	5	22.7	17	77.3		2	9.1	20	90.9
Fractionating column	3	13.7	19	86.3		1	4.5	21	95.5
Lab coats	5	22.7	17	77.3		2	9.1	20	90.9
Measuring cylinders	22	100	0	0		7	31.8	15	68.2
Average percentages (Chemistry)		**57.37**		**42.63**			**28.64**		**71.36**

PHYSICS									
Meter rulers	5	22.7	17	77.3		7	31.8	15	68.2
Pendulum bobs	13	59.1	9	40.9		13	59.1	9	40.9
Stop clocks	16	72.7	6	28.3		6	28.3	16	72.7
Venier sliding callipers	2	9.1	20	90.9		5	22.7	17	77.3
Spring balance	7	31.8	15	68.2		2	9.1	20	90.9
Micrometer screw gauge	7	31.8	15	68.2		6	28.3	16	72.7
Capillary tubes	1	4.5	21	95.5		0	0	22	100
Ripple tank	1	4.5	21	95.5		1	4.5	21	95.5
Lenses	22	100	0	0		13	59.1	9	40.9
Copper and steel wires	19	86.3	3	13.7		16	72.7	6	28.3
Magnets	2	9.1	20	90.9		1	4.5	21	95.5
Pulleys	5	22.7	17	77.3		1	4.5	21	95.5
Glass prisms	3	13.7	19	86.3		3	13.7	19	86.3
Masses and Mass hangers	16	72.7	6	28.3		13	59.1	9	40.9
Lever balance	0	0	22	100		0	0	22	100
Overflow can	1	4.5	21	95.5		1	4.5	21	95.5
Curved mirrors	6	28.3	16	72.7		5	22.7	17	77.3
Average percentages (Physics)		**29.79**		**70.21**			**28.81**		**78.19**
BIOLOGY									
Microscopes and slides	13	59.1	9	40.9		5	22.7	17	77.3
Specimen bottles	11	50	11	50		4	18.2	18	81.8
Dissecting kits	4	18.2	18	81.8		1	4.5	21	95.5
Hand lens	13	59.1	9	40.9		2	9.1	20	90.9
Petri dishes	16	72.7	6	28.3		5	22.7	17	77.3
Quadrants	5	22.7	17	77.3		3	13.7	19	86.3
Scalpels	17	77.3	5	22.7		11	50	11	50
Vertebrate skeleton	5	22.7	17	77.3		9	40.9	13	59.1
Average percentages (Biology)		**35.10**		**64.90**			**22.72**		**77.28**
Total Average Percentage		**40.75**		**59.25**			**26.72**		**73.28**

4.9. Laboratory Assistants' Responses on Laboratory Status and Use

Interviews on the laboratory assistants were carried out during the month of January 2009. Most laboratory assistants cited the following as some of the causes that make students not be able to undertake practical lessons in their schools: lack of basic infrastructure that is fittings and water, large population of students, lack of working tables and benches, lack of apparatus and chemicals, lack of enough laboratories, some laboratory assistants double up as office messengers, some teachers are allergic to certain chemicals, some experiments are too involving hence they are rarely carried out by teachers and new teachers are not confident in giving out practical work.

Laboratory assistants were also asked to state whether laboratory apparatus/ chemicals are bought in good time when orders are placed in their respective schools. Table 4.9.1 presents the results of the findings.

Table 4.9.1: Whether laboratory apparatus/ chemicals are bought in good time when orders are placed

Response	Frequency	Percentage
Yes	9	60
No	6	40
Total	18	100

The researcher also sought to find out how often laboratory apparatus/ chemicals are bought in schools. It can be observed that the majority (60%) of the schools buy laboratory apparatus/ chemicals regularly. It can be further noted that 40% of the respondents

observed that schools rarely buy chemicals and apparatus on time. The reasons given by the laboratory assistants for the delay in buying laboratory apparatus and chemicals are; lack of funds, suppliers are far and long procedures for procuring.

Table 4.9.2: Types of experiments performed by students in schools.

Type	Frequency	Percentage
Group experiments	7	38.9
Teacher demonstrations	9	50.0
Individual experiments	2	11.1
Total	18	100

Table 4.9.2 shows that laboratory assistants also concurred with the teachers that the most dominant type of experiments in schools include group experiments (38.9%) and teacher demonstrations (50%). According to the respondents (11.1%), individual experiments are rarely performed hence an indication that there is a bias towards teacher demonstrations, which are less student centered.

From the results, it can be noted that there is great need to improve on our laboratories in terms of their state and use. When the gaps seen are rectified, students will be able to perform better in science subjects and many more will be able to qualify for science based courses in the university.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study was to investigate the availability and use of school laboratory facilities in selected secondary schools in Trans-Nzoia district and how they influence students' achievement in the science subjects.

This study is significant especially to the development of knowledge about the role of school laboratory in teaching – learning process in science subjects. Sensitization of stakeholders in the education sector will be done to re-evaluate their position as regards school laboratory facilities provision in order to increase interest and participation in science subjects among secondary school students.

And for the policy makers in education, the results will show how to come up with strategic interventions, especially in school laboratory facilities provision and management. Finally, the findings of this study will only reflect the situation in the district. Hence, the findings may not be representative of all secondary schools in Kenya.

5.2 Summary

In the introductory part, the background information to the study was considered by highlighting the problem of school laboratory facilities and how they influence students' achievement in the science subjects. Another issue explained in the introduction is the

justification of the study and its significance to the development of practical science education in Kenya. Three null hypotheses were tested using chi square. All the hypotheses yielded significant relationships necessitating their rejection. It can therefore be concluded that:-

a. The state of school laboratory facilities affects students' achievement in national examinations.
b. The frequency of laboratory sessions affects students' achievement in science subjects in national examinations.
c. The provision of laboratory facilities affects students' achievement in science subjects in national examinations.

An outline of the essential aspects of the study including the purpose of the study, research questions to be answered and the theoretical framework of the study were also given based on Bailey's educational systems approach. The educational systems approach emphasizes on the relationship between inputs and the outputs within a system.

The review of literature discussed the main issues in the state and use of laboratories. The purpose of the review was to link what was already known about the issues that were investigated with the main research problem. Thus, the issues considered included:- laboratory in science education, learning science in the school laboratory, laboratory work and students' attitudes, conditions for effective learning in laboratories, students' perceptions of the laboratory learning environment, social interaction in laboratories and its consequences for learning. It further considered; differences in learning styles and

cognitive abilities, students' perceptions of teachers' goals in science laboratory activities, school laboratories as conventional locations for teaching and learning process, the repair, maintenance and state of laboratory facilities, teachers' expectations and behavior in using the laboratory, the laboratory guide, assessing students' laboratory skills and understanding of inquiry and teacher education and professional development and laboratory use.

The research design and methodology explained how data was collected, presented and analyzed. The research design used descriptive survey design. The methods used to collect information included questionnaires for teachers and head teachers, an interview schedule and checklist for laboratory assistants. The presentation and analysis of the data showed how data was presented and analyzed to determine the research objectives.

5.3 Conclusions

The entry behaviour of students to candidate classes in most schools was not below average hence if practical lessons are emphasized they can do well in national examinations.

Most schools indicated that they had a laboratory despite a small percentage that said they did not have. It therefore, means that laboratory lessons can take place in most of the schools if apparatus and chemicals are supplied by the school administration.

The uniqueness of the laboratory lies principally in providing students with opportunities to engage in processes of investigation and inquiry but despite this, majority of the schools were found not to have enough laboratories to be used by all the students in all the three sciences. Therefore, quite a number of students miss out on some laboratory sessions.

Majority of the teachers did carry out practical lessons more frequently or frequently though most of the practical lessons carried out by the teachers were group experiments and teacher demonstrations. This denies students a chance to enhance their understanding of scientific concepts and also develop interest and motivation, scientific practical skills and problem solving abilities, scientific habits of mind and understanding of the nature of science. Laboratory experiences are, therefore, very important for a student to perform well in science subjects' examinations.

Most teachers in the district expressed their desire and willingness to carry out practical lessons so that students can be able to handle/ manipulate the apparatus on their own. However, due to certain factors such as lack of apparatus, saving on time, lack of chemicals among others hinder them from doing so. This implies that the students are deprived of the necessary skills that can make them be able to carry out an experiment on their own, hence hindering them from performing well in national examinations in the sciences. Some teachers even emphasized teaching techniques that are less aligned with students' ability to earn high grades, hence the use of group experiments and teacher demonstrations in absence of enough apparatus and chemicals and on saving time.

Meaningful learning in the laboratory would occur if students were given sufficient time and opportunities for interaction and reflection. If students do not have time or opportunity to interact and reflect on central ideas in the laboratory then they will have little ability to express their interpretation and beliefs about the meaning of their inquiry. Many teachers in the district, therefore, strongly felt that lack of resources such as apparatus, teaching aids, furniture and chemicals has affected negatively the students' performance in science subjects and so underscoring the importance of a well equipped laboratory in each school in the district.

Laboratory work is an important medium for enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science. Thus most teachers strongly felt that lack of enough laboratory sessions for students tends to make students have a negative attitude towards science subjects since their interest in sciences is less stimulated and also makes them under perform in these subjects in the national examinations.

Most schools have an average of two laboratories, which is not enough for the three sciences offered in schools in the district. Teachers had to teach without a laboratory session at times, hence denying students a chance to enhance their practical skills. This had a big impact on their performance in the national examinations by registering of very low scores. In addition, it was observed that most of the laboratories though short in the required number, a large number of them were also incomplete in terms of construction and equipping.

Many teachers in the district pointed out that despite chemistry being the most equipped in terms of laboratory equipments as compared to physics and biology, it still performed poorly compared to the two that were not well equipped. This implies that chemistry does not make full use of the facilities available.

Although creating a healthy learning environment is an important goal for many contemporary science educators, it was however, found that many laboratories did not have enough space to accommodate a whole class during a practical lesson. This implies that the teaching-learning process during a practical lesson is affected negatively due to congestion of students in the laboratories.

Most schools in the district had laboratory assistants who were qualified to handle laboratory assignments. This implies that teachers could be motivated to undertake laboratory sessions since there is qualified personnel who can assist in preparing laboratory lessons.

Repair and maintenance of existing buildings and related facilities is not only a legal requirement but, a legal obligation. This area requires continued funding to ensure that facilities are maintained in a state of acceptable standards. Schools have control over a significant part of their expenditure and can determine their own educational priorities-repair and maintenance of their buildings and related facilities. Most school administrations did frequently buy/ repair laboratory facilities though some rarely did so.

Most teachers in the district observed that the practical manuals were inadequate with only a very small percentage indicating that they were enough. This causes confusion to students when doing a practical because they lack of proper instructions to guide them through the practical.

Many schools in the district need to upgrade their laboratory facilities to attract more science students. Lack of laboratory facilities has forced quite a number of students in the district to take the minimum number (two) of science subjects rather than the three on offer.

5.4 Recommendations

The findings of this study have far reaching implications to education administrators and planners in the country today. The recommendations of the present study are outlined in the following paragraphs:-

1. There should be regular inspection of the physical conditions of the school laboratories since they play an important role in enhancing attitudes, stimulating interest and enjoyment, and motivating students to learn science.

2. The inspectorate arm of the Ministry of Education should organize regular visits to the schools in the district to record the number of students who take all the three sciences in order to evaluate the cause of low enrolment in science subjects.

3. The inspectorate should organize seminars to sensitize the school administrators and teachers on the need to equip the laboratories and to take students practicals sessions seriously.

4. The inspectorate section should also consider practical activities for teaching as one of the priority areas in professional development activities including workshops and in-service education. This will ensure teachers are sensitized on the need to prepare their lessons adequately.

5. All trainers of science education students should be professionally qualified teachers so that they can serve as role models in the training of students on the importance of laboratory activities.

6. Teachers should look at the symptoms of the difficult in science practical work as their own problem and through proper planning prepare a programme of action to achieve the desired change through student centered laboratory activities.

7. Teachers' management of poor performance in science subjects should start with their positive interpretation and perception of the problem and willingness to take appropriate remedial action.

8. There is need for tutors guide for training science teachers in the colleges of education to harmonize the curriculum for secondary schools science teachers in order to bring out an all round teacher upon graduation.

5.5 Suggestions for further research

During the course of this study a number of issues emerged that would require further investigation. The following are therefore, the suggestions for further research.

1. There is need for assessment of how time spent in laboratory activities affects the learning environment.

2. Research should be carried out to assess how the nature of students' activities in the laboratory affects the learning environment.

3. An investigation into the attitude of teachers towards students' practical lessons and how it can be improved.

4. Similar research should be undertaken in other districts in Kenya that post poor performance in science subjects to confirm the findings of this study.

5. Further research should be undertaken to confirm the claims made by the teachers that the primary curriculum lacks much emphasis on laboratory activities, hence leading to poor performance in sciences at secondary school level.

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APPENDICES

Appendix 1: Questionnaire for the Science Teachers

The following questionnaire has been prepared for the science teachers in secondary schools to solicit information for the study entitled "Availability and use of school laboratory facilities and their influence on students' achievement in sciences: A case of secondary schools in Trans-Nzoia district secondary". Please respond to all questions by putting a tick (√) in the appropriate box or by filling the correct information in the spaces provided. The information you will provide will be kept confidential and will not be used anywhere.

Part I Baseline data

Name of school (Optional) _____

Type of school: Mixed Day/boarding [ ] single sex boarding [ ]

Mixed boarding [ ] Mixed day [ ]

District [ ] Provincial [ ]

Teachers teaching experience 0-5 Years ( ) 6-10 Years ( )

11-15 Years ( ) 16-20 Years ( ) 21 and above Years ( )

Subject	Which of the following subjects do you teach?
Biology	
Chemistry	
Physics	

Part II **A: Laboratories**

1. Do you have a laboratory/ laboratories? Yes ( ) No ( ).

   Is the laboratories discipline specific? Yes ( ) No ( )

If yes, are they enough for all the science subjects offered at your school?

Yes ( ) No ( )

2. How do you rate the following items?

ITEM	More frequently	frequently	rarely	Very rarely
How often are laboratory facilities bought /repaired by the administration?				
How often do you conduct practical lessons?				

B. <u>Laboratory facilities</u>

1. a) What proportion of students took all the three science subjects in form four in the following years?

Proportion (%)	2002	2003	2004	2005	2006
Less than 25					
Between 25 and 50					
Between 50 and 75					
Above 75					

b) Does lack of enough laboratory facilities hinder the rest of students from taking all the three science subjects? Yes ( ) No ( )

2. How has the following influenced the performance of science subjects in your school?

Indicate with a tick (√)

ITEM	INFLUENCE			
	Very strongly	Strongly	Average	No effect
Number of Laboratories				
Laboratory teaching aids				
Number of laboratory sessions				
Laboratory furniture				
Laboratory management				
Laboratory apparatus				
Laboratory chemicals				

3. Do you have laboratory assistants in your school?

Yes ( ) No ( )

If yes, are they qualified enough to handle laboratory assignments? Yes ( ) No ( )

ii) If no, do you prepare chemicals and arrange apparatus for experiments as well as teach at the same time? Yes ( ) No ( )

4. How would you rate the adequacy of the following items in your school?

Item	Adequate	Inadequate
Students' practical manuals		
Apparatus for experiments		
Laboratory chemicals		

Laboratory assistants practical manuals		
Laboratory reference books		
Laboratory furniture (stools and tables)		
Number of laboratories		

5. To what degree do you agree/ disagree with the following items (tick one).

ITEM	Strongly Agree	Disagree	Undecided	Agree	Strongly agree
Adequacy of laboratory facilities in my school has affected the performance of students in science subjects?					
Upgrading the laboratory facilities will attract more students and make them perform better?					

6. Do you consider your laboratory as an up-to-date school laboratory?

Yes ( ) No ( )

If No, What do you think needs to be done to modernize it?

_____

_____

_____

_____

7. Indicate the total number and whether the laboratory facility mentioned below is complete or incomplete. Please use the table below

Facility/ item	Number	complete	Incomplete	State			
				Excellent	good	fair	poor
Physics laboratory							
Chemistry laboratory							
Biology laboratory							

Comment on anything else about the above facilities ----------

---

---

8. (i) Do the laboratory/ laboratories have constant supply piped water?

Yes ( ) No ( )

If No, how do you get water for experiments in the laboratories?

Nearby stream ( )

Piped and on national water grid ( )

Bore holes/ wells ( )

Any others (please specify) ----------

(ii) How would you rate the source(s) you have selected (i) above?

Reliable ( ) Not reliable ( ) don't know ( )

9. How do you rate the performance of your students in science subjects?

Below average	average	Good	Very good

10. Among the following three science subjects which one had the highest mean score in the following years?

YEAR	CHEMISTRY	PHYSICS	BIOLOGY
2002			
2003			
2004			
2005			
2006			

11. Among the following laboratories which one in your view has more facilities in your school?

LABORATORY	THE MOST EQUIPED
Chemistry	
Physics	
Biology	

12. Which one of the following types of experiment is the most frequently used in your school?

    Group experiments ( )

    Demonstration ( )

    Other (specify) _____

13. What makes you carry out the type of experiment in question 12 above?

    Lack of apparatus ( )

    Lack of chemicals ( )

    Lack of laboratory assistant ( )

    Lack of practical manuals ( )

    Save on time ( )

    Lack of reference books ( )

14. Do the laboratories have adequate space for all the students?

    Yes ( ) No ( )

    If yes, do you ever undertake individual experiments? Yes ( ) No ( )

15. Do you consider your laboratory/ laboratories to be having sufficient apparatus/ specimens/ chemicals? Yes ( ) No ( )

If No, how do you supplement your deficiencies during practical lessons?

_____

_____

_____

_____

16. Comment on anything else about your laboratories

_____

_____

_____

_____

_____

_____

_____

Thank you for your co operation.

Appendix II: Questionnaire for the Head Teachers

The following questionnaire has been prepared for the head teachers in secondary schools to solicit information for the study entitled "Availability and use of school laboratory facilities and their influence on students' achievement in sciences: A case of secondary schools in Trans-Nzoia district". Please respond to all questions by putting a tick (√) in the appropriate box or by filling the correct information in the spaces provided. The information you have provided will remain confidential and will not be used anywhere apart from this study.

Part I. Baseline Data

Name of school (Optional) _____

Teaching Experience 0-5 years ( ) 6-10 years ( )

11-15 years ( ) 16-20 years ( ) 21 and above years ( )

Type of school: Mixed day/boarding [ ] single sex [ ]

Mixed boarding [ ] Mixed day [ ] National [ ] Provincial [ ] District [ ]

Any others (please specify) ----------

Indicate by a tick (√) whether your school has any of the following number of streams

Single (one stream) ( ). Double (two streamed) ( )

Triple (three streamed) ( ). Four streamed ( )

Any Others (Please specify) ----------

Part II: - Admission to science faculties at Public Universities.

1. How many students were admitted for science courses at the universities from your school in the last five years?

YEAR	Number of students who qualified for university (attained cut off points)	Number of students who were selected for science courses
2002		
2003		
2004		
2005		
2006		

B. Financial Provision (Current year)

i) Is there any finance set aside for:-

a) Putting up new laboratory facilities? Yes ( ) No ( )

b) Repair, improvement and maintenance? Yes ( ) No ( )

C. Performance

Do you believe good laboratories facilities contribute to good performance of science subjects in your school? Yes ( ) No ( )

Comment on the performance of science and how it relates to laboratory facilities in your school.

Thank you for your co operation

Appendix III: Interview Schedule for the Laboratory Assistants

The following interview schedule has been prepared for the laboratory assistants in Secondary schools to solicit information for the study entitled "Availability and use of school laboratory facilities and their influence on students' achievement in sciences: A case of secondary schools in Trans-Nzoia district". The information you will provide will be kept confidential and will not be used anywhere other than this study.

PART 1 Baseline data

Type of school:	Mixed day/ boarding	[ ]	single sex	[ ]
	Mixed boarding	[ ]	Mixed day	[ ]
	Provincial	[ ]	District	[ ]
Working Experience	0-5 years	[ ]	6-10 years	[ ]
	11-15 years	[ ]	16 and above	[ ]

Professional qualifications

1. Have you attended any training related to laboratory work?

Yes [ ] No [ ]

If yes, what qualification have you attained?

Diploma [ ], Certificate [ ] None [ ]

Any other (specify) _____

PART 2 Laboratory usages by teachers

1. Which one of the following types of experiment is the most frequently used by the science teachers in your school?

   Individual experiments [ ] Group experiments [ ]

   Demonstration [ ] other (specify) _____

2. Do students in your school have practical books for doing experimental work?

   Yes [ ] No [ ]

   If No where do they write their experiments _____.

3. How frequently do science teachers in your school use the laboratory /laboratories?

   Very frequently [ ]

   Frequently [ ]

   Less frequently [ ]

   Rarely [ ]

4. In your own opinion are you being under utilized or over utilized in relation to what your laboratory can offer?

   Under utilized [ ]. Moderate [ ] Over utilized [ ]

5. Do most of the things requested by the teachers for experiments found in the laboratory /laboratories?

   Yes [ ] No [ ]

   If No, how do you handle such situations?

   _____

   _____

   _____

   Are the laboratory apparatus/ chemicals/materials bought in good time when an order is placed to the administration?

   Yes [ ] No [ ]

   If No, what reason(s) is given for the delay?

   _____

   _____

   _____

6. In your own assessment what are some of the reasons that prevent science teachers in your school from using the laboratory /laboratories as frequently as it is required?

   _____

   _____

   8. In your own assessment what needs to be improved in your school laboratory /laboratories?

Appendix IV: Checklist for laboratory assistants.

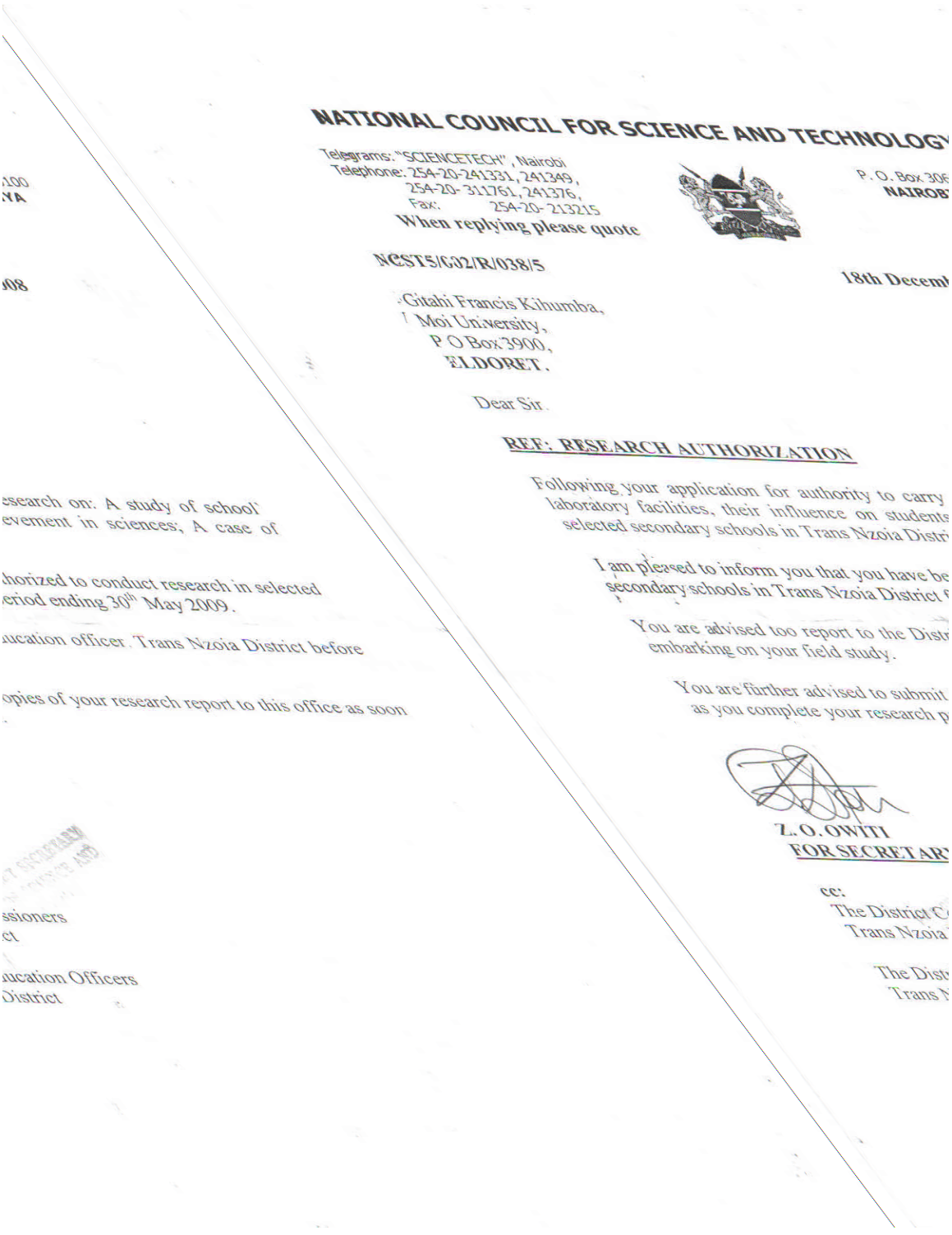
ITEM	YES	NO		ENOUGH	NOT ENOUGH
CHEMISTRY					
Conical flasks					
Beakers					
Bunsen burners and wire gauze					
Kipps gas generator					
Burettes					
Pipettes					
Chemical balance					
Round/ flat bottomed flasks					
Funnels					
Glass trough					
Thermometers					

Crucibles					
Retort stands, clamps and tripod stand					
Desiccators					
Mortar and pestle					
Combustion tubes, spatula and deflagrating spoon					
Cork borers					
Fractionating column					
Lab coats					
Measuring cylinders					
PHYSICS					
Meter rulers					
Pendulum bobs					
Stop clocks					
Venier sliding callipers					
Spring balance					
Micrometer screw gauge					
Capillary tubes					
Ripple tank					
Lenses					
Copper and steel wires					
Magnets					
Pulleys					

Glass prisms					
Masses and mass hangers					
Lever balance					
Overflow can					
Curved mirrors					
BIOLOGY					
Microscopes and slides					
Specimen bottles					
Dissecting kits					
Hand lens					
Petri dishes					
Quadrats					
Scalpels					
Vertebrate skeleton					

Thank you for your co operation

Appendix V: RESEARCH PERMIT



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When replying please quote

P. O. Box 30
NAIROB

NCST5/C02/R/038/5

18th Decem

Gitahi Francis Kihumba,
Moi University,
P O Box 3900,
ELDORET.

Dear Sir

REF: RESEARCH AUTHORIZATION

Following your application for authority to carry
laboratory facilities, their influence on students
selected secondary schools in Trans Nzoia Distri

I am pleased to inform you that you have be
secondary schools in Trans Nzoia District f

You are advised too report to the Distr
embarking on your field study.

You are further advised to submit
as you complete your research p

Z. O. OWITI
FOR SECRETAR

cc:
The District C
Trans Nzoia

The Distr
Trans N

esearch on: A study of school
evement in sciences; A case of

horized to conduct research in selected
eriod ending 30th May 2009.

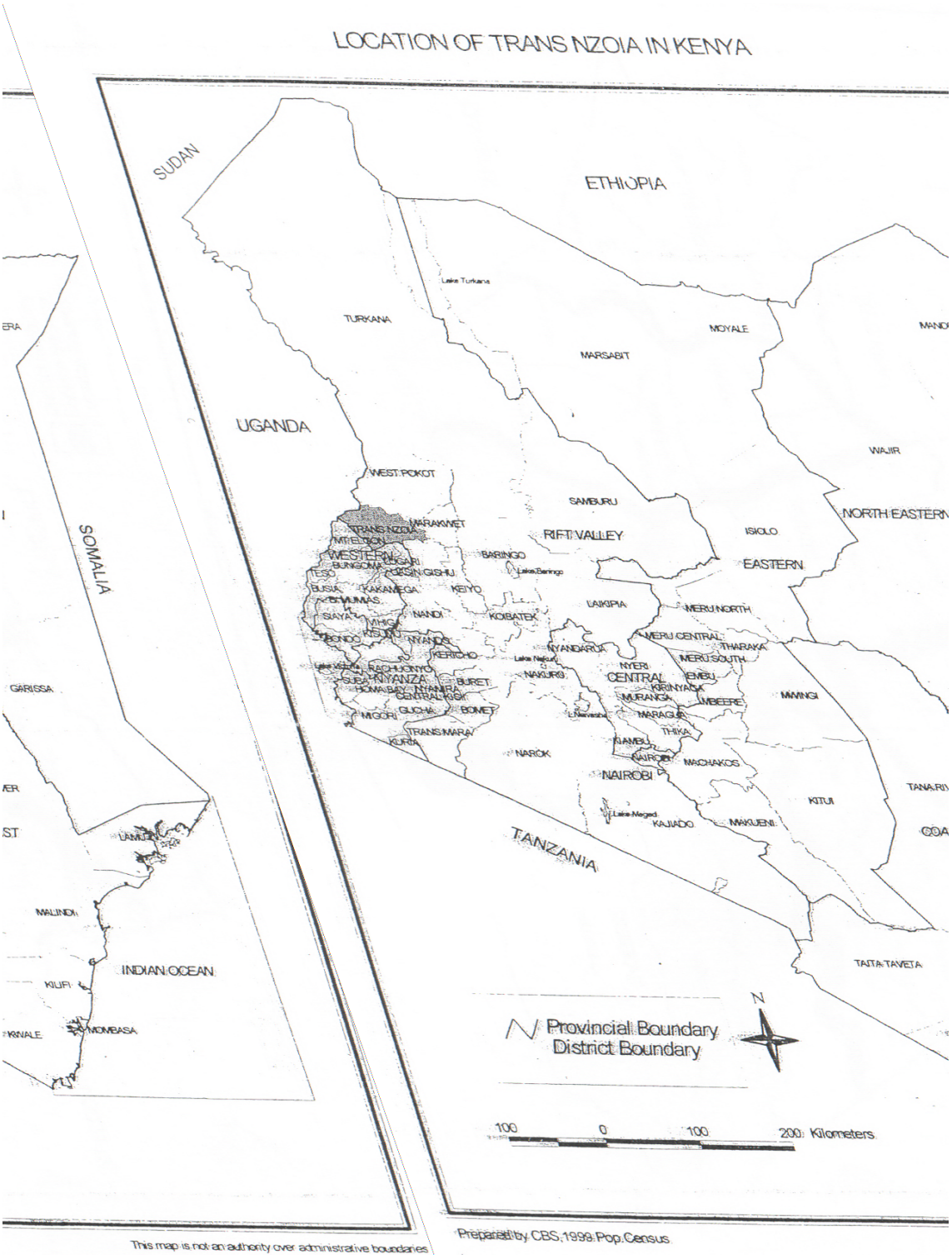
ucation officer Trans Nzoia District before

opies of your research report to this office as soon

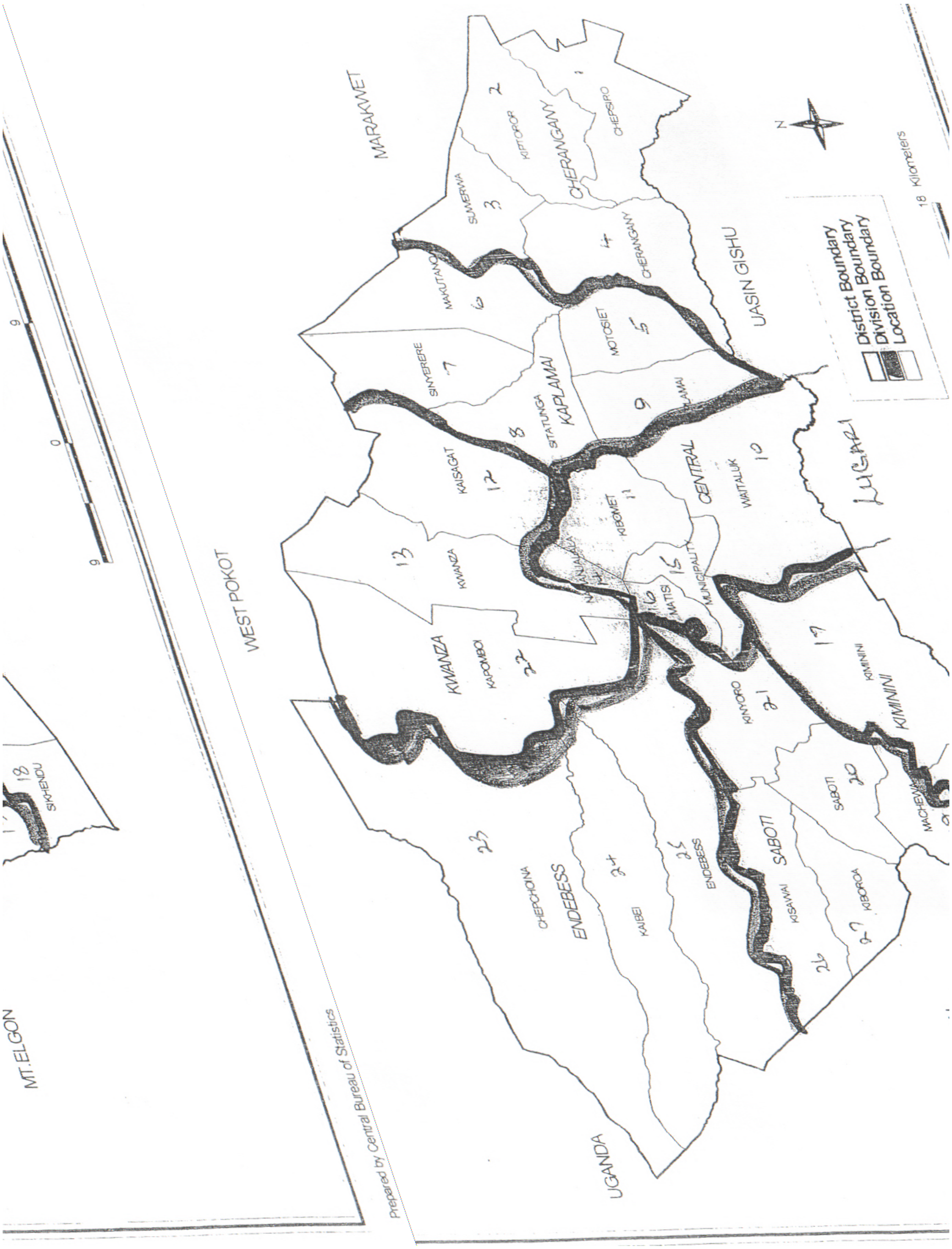
ssioners
ct

ucation Officers
District

Appendix VI: Map of Kenya



Appendix VII: Map of Trans-Nzoia


MARAKWET
WEST POKOT
UASIN GISHU
MT.ELGON
UGANDA
LUGARI
CHERANGANY
KAPLAMAI
CENTRAL
KWANZA
ENDEBESS
SABOTI
KIMININI
SUWERWA
KIPTOROR
CHEPSIRO
CHERANGANY
MAKUTANO
MOTOSIET
SINYERERE
STATUNGA
KAPLAMAI
KAISAGAT
KIBOMET
WAITALUK
KWANZA
MUNICIPALITY
MATISI
KAPOMBOI
KINYORO
KIMININI
SABOTI
MACHEWA
CHEPCHOINA
KAIBEI
ENDEBESS
KISAWAI
KIBOROA
SIKHENDU
District Boundary
Division Boundary
Location Boundary
9
0
9
18 Kilometers
N
Prepared by Central Bureau of Statistics